FACTORY MANAGEMENT and MAINTENANCE

SEPTEMBER, 1933

Successful Selling Begins in the Plant

Radio assembly. Simple sub-assemblies, minimum movement of parts, testing at end of assembly assure sets that meet standards of workmanship and performance

Busy the Year Round

Crosley reorganizes plant, people, and products; counterbalances one seasonal product with another; operates at a profit

L. C. Morrow

Editor

DEPRESSION accomplishments of the Crosley Radio Corporation demonstrate that successful selling begins in the plant. Now in the black, though having shown a pinkish tinge in '32, this organization has weathered well; and may look back at an enviable record of people kept at work.

The end of '29 found the Crosley organization operating a main plant with two smaller plants, each a mile away and two miles from each other. Part of the main plant was old, part new; the new part had just been built to take over the operations from the other two.

Growing in jumps, as the radio industry grew, it was only natural that the plant was here and there. As things went in '29 and for a few years before that, whatever plant facilities were available were used. It was necessary to have results under any conditions. But, natural

or not, scattered plants made handling bad. Transportation was expensive—consumed time. Parts production didn't always flow smoothly. There were three separate organizations of people.

Which explains the first major step toward successful selling—doing everything in one plant. It's that way now—a six-and-eight story building, two smaller multi-story, and a single-story.

Major step number two consisted of remaking the organization. The reorganization work extended over the year 1930. It was a year of working principally in men, rather than materials or machines. The job was to merge three organizations into one, at the same time changing from a small into a medium-size manufacturing plant; and to introduce more development, research, and standardization in design.

During this reorganization period the plant "went technical." Into the manufacturing department, manned up to that time principally by "practical men," were filtered technical engineers. These men set out to coordinate design and manufacture, to introduce more engineering into fabrication, handling, inspection, assembly; ended up by doing many of the jobs themselves; became department heads, parts of the shop organization. The best of the "practical" men were retained to effect a balanced shop personnel. Now about half of the department heads have served in engineering departments, or are technically equipped so to serve. To the asset "plant," the second major step added the asset "people." Their work is the doing of lots and lots of details, that by accumulation make the success of the company. It's the customer who determines the extent of this success, and, in the Crosley philosophy, the customer is interested only in tangibles, that is, in the material and workmanship put into what he buys. These tangibles, of course, have their foundation in the company's research, development, and design.

The people of the company are divided into four groups or Divisions: Engineering, Materials, Accounting, Manufacturing. Getting a radio ready for a customer is done about like this: (1) The Engineering Division designs; (2) Manufacturing Division produces "time-study" models; (3) Materials Division releases 200 sets of parts; (4) Manufacturing Division sets up and operates an assembly line.

Sounds simple; is—but makes necessary allowance for the important incidental complexities that enter into the making of a quality radio set. To illustrate: So far as having a fine receiver is concerned, the design may be all that anyone could hope for. Then the manufacturing division gets busy making its time-study models, which means predetermining by means of time-study and standard costs just how the fabricating and assembly details are to be carried out, and what the time allowances are to be—hence the operators' pay and the cost of manufacture. Assume that it runs into difficulties, finds that too much time is required for this or that. Whatever is causing the trouble is referred back to the engineering department for reconsideration, is made to satisfy both production and design requirements.

As soon as they are available, samples of the 200 parts that the materials division is going to release are inspected by the manufacturing division. And as soon as possible after that five or six sets are completed on the trial assembly line, are checked by the quality control engineer, and tested by the engineering department. Ob-

Some of the machine-tool equipment for making refrigerator compressor parts. The piston and shaft holes, bored on these machines, are made slightly undersize in preparation for a later operation that will bring them to exact size

"Bearinizing," which breaks in the bearing surfaces of connecting rods. This operation takes off the "fuzz," gives increased density to the bearing, is said to have the same effect as a year of running

jectives are maintenance of quality, prevention of loss of parts-production and assembly.

In the consolidation of plants it has been necessary to incur expense —for buildings, equipment, moving. For moving again, too, because at first separate floors were found for the incoming plants, with a later arrangement placing together all component parts for a given set. Now each assembly line is arranged with parts bins at one end, and final set testing at the other.

Testing at the end of assembly lines meant remodeling the entire system of testing. Instead of a central test room, obtaining signals from a multiplicity of sources, there is now a single installation of high-frequency generating equipment, with a distribution system running throughout the plant. To design, build, and install the system cost some thousands of dollars, but among the results are the elimination of useless transportation of sets, and the releasing of an entire floor, formerly devoted to testing, now used in the fabrication of another product.

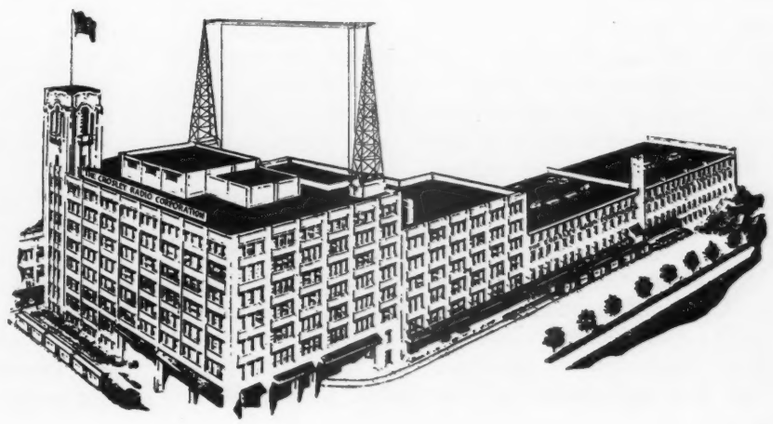
In all of the consolidation and reorganization outlined there was involved expenditure for equipment. Wherever proved economical by test, conveying equipment is used —belts for assembly, rollers for fabrication, chains for transportation. The system is now arranged so that, within reasonable demands, anything can be transported any place.

We now arrive at the third major step in keeping the sales department always supplied with salable products, produced at low cost to allow competitive ability. It is the manufacture of refrigerators. This Crosley activity was added during the depression. As with radios, the sale and manufacture of refrigerating equipment are seasonal. Refrigerators offset radios, the plant force is kept busy the year round, fixed expense is too heavy for neither.

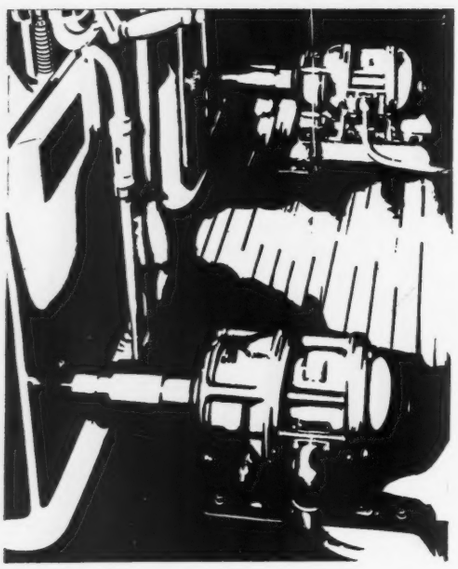
The experimental work had been carried on for several years before the refrigerator was put on the market in 1932. Actual manufacture, therefore, with the attendant expenditures for equipment, took place in the middle of the depression. Some $180,000 was spent on machine tools, welding machines, fixtures, gages, and small tools for this product only. It is now a going business, justified of itself alone, doubly justified because it economically counterbalances the company's other product, radio.

Expenditure of a half million during the world's worst set-back, by a company of medium size, implies no lack of confidence in product. There is no lack. There is no overlooking the influence upon sales exerted by products made to high standards of quality at low manufacturing costs.

Second of a number of articles on production's responsibility for sales. The third is scheduled for early publication



Principal Developments in Mechanical Power Transmission



Continuing our summary of the more important changes in the widely used items of equipment. Last month's article treated Plant Service Equipment

Speed-Changing Equipment

Most frequently mentioned, among reducer announcements, has been some form of the geared motor-reducer, in which the speed-reducing transmission equipment is incorporated in the motor unit itself. In general, such an arrangement makes it possible to take advantage of small, high-speed motors with a saving in first cost. The units as now available are easy to mount and align. As a rule the motor can be removed without disturbing the connection between motor and driven machine.

Geared motors usually use anti-friction bearings to obtain capacity that is great in proportion to space used. Such bearings lend themselves readily to supporting the combination of thrust and radial loads produced by the reducing gears in most units.

Variable-speed gear units often are used; and, if not, standard parts are such that ratios can be changed easily by the users. These transmission units can be had for straight-through, right-angle, and vertical application.

A typical, fractional-horsepower motor-reducer provides gear reduction ratios of 10 to 1, 20 to 1, and 40 to 1, with standard motor speeds of 1,125 and 1,725 r.p.m. The gear end consists of a separable, alloy-steel worm and bakelite gear, mounted in a grease-tight housing and forming an integral part of the end shield of the motor.

In another motor-reducer, available in sizes up to 15 hp., the speed-reducing mechanism is fully inclosed in a two-piece housing bolted to the motor frame, and is splash lubricated.

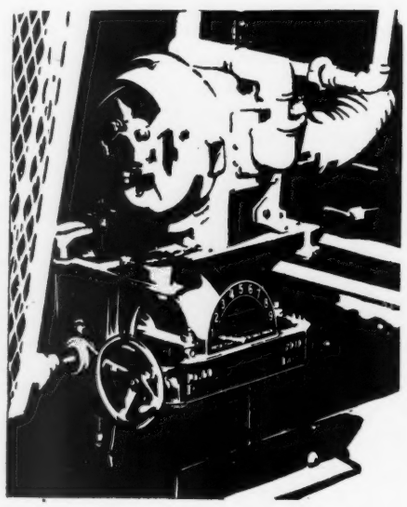
One manufacturer offers a unit with speed ratios up to 450 to 1 for open, inclosed, polyphase, and single-phase motors up to 10 horsepower.

Units with large reduction speed ratios and using motors up to 20 hp. are available.

In motor-reducers there are two general types of mechanical construction: (1) Wherein the motor carries the gear; (2) Wherein the gear carries the motor.

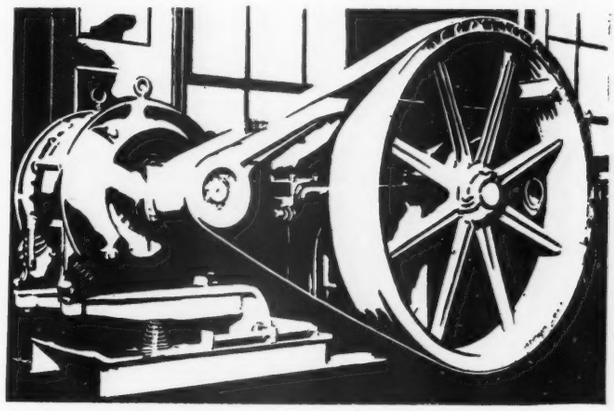
Motor-reducers can also be classed among four general groups according to kind of gearing used: (1) Planetary system; (2) Worm gear; (3) Simple train of gears; (4) Miscellaneous combinations.

Geared speed-reducer units are available, operating on much the same principle as an automobile transmission, providing as many as four speed changes.



Explosion-proof, dust-proof, oil-tight housings have been designed for reducers of this type. Gear design improvements have increased ratings by permitting more horsepower

Equipment



to be put through a unit of a given size. In one reducer the shaft can be turned end for end to permit using the opposite and unworn side of the teeth.

For transmitting power over a wide range of speeds which may be changed at will through infinite gradations, geared and hydraulic types of equipment have been introduced.

In the geared type the usual method makes use of two pairs of facing conical pulleys, or disks, connected by means of a V-belt or specially designed chain. On changing speed, the self-adjusting chain or belt rises between one set of disks and descends between the other, so that while the input shaft, connected to a motor or other source of power, turns at constant speed, the output shaft is adjustable to the desired revolutions per minute. Speed changes are made without stopping the drive, and even the smallest speed variation may be made with accuracy.

A variable-speed countershaft consists of a motor pulley of facing-conical-disks design, mounted on the shaft of a sliding-base electric motor, and a countershaft adjustable on a common bed plate. Drive to flat-face pulley of countershaft is by means of V-belt; from countershaft by means of flat belt, V-belt, or chain.

Units utilizing positive chain drive were introduced in 1930. All the elements are built into a single housing, and are automatically splash-lubricated. Radial teeth are cut in the conical faces of the driving disks and the self-adjusting teeth projecting beyond the sides of the chain are arranged to engage these radial teeth.

Speed control usually is obtained by means of handwheels, but units are available in which the disks are moved together or apart by means of a motor remotely controlled.

Hydraulic variable-speed transmission units usually contain a variable-displacement, constant-speed oil pump and a constant-displacement, variable-speed oil motor. When the pump is connected to a constant-speed source of power, and piped to the motor, there results a variable-speed transmission that can be applied to drive conveyors, paper mills, and other machinery in which smooth, stepless speed variation is desired. By varying the displacement of the pump, the speed of the motor can be varied from 0 to 800 r.p.m., practically independent of variations in load.

Short-Center Drive

A power transmitting device extensively developed during the past three years is the pivoted-motor-base arrangement for short-center belt drives. The weight of the motor, supported by pivot and belt, maintains the proper belt tension. Adjustable arms on the base permit the motor to be moved, in relation to the pivot shaft, to vary belt tension to suit the specific application. The device is now available for vertical or horizontal drives.

Belting

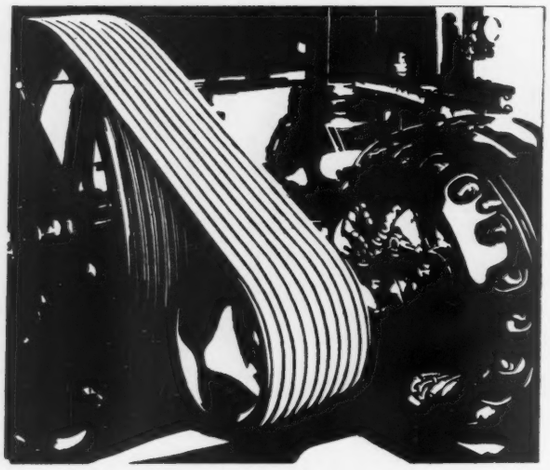
Leather belting has been developed in which greatly reduced stretch is featured. By means of improved manufacturing processes in which many of the old handicraft operations have been superseded by mechanical methods, such belting has been given increased flexibility and strength. This has been accomplished by cementing together strips of leather the thickness of which is accurately determined.

Leather belting with treads has been introduced. The maker points out that the contact surface is similar in principle to the contact surface of non-skid automobile tires, claims that it improves gripping power, and that the longitudinal ribs cause belt "tracks" on the pulley, preventing the belt from running off if suddenly overloaded.

Improved types of rubber and fabric belts have been introduced. Smooth running, low slippage, and high flexibility have been the aims of the manufacturers. The rubber V-belt now available usually has a rubber covering, inside of which are a fabric cover and filler cord. There is an endless rubber-cord belt with cords spiraled continuously. In one type of V-belt the load is said to be carried entirely by a layer of high-tensile, low-stretch cords, placed in the section of the belt that is under neither the tension nor the compression imposed by flexure. The sections of extreme tension and compression, above and below the neutral section, are made of rubber stock.

Chains

Transmission chains are a relatively stable line. Advance has been principally metallurgical. Thus, a new



processing of malleable iron makes possible chain material of great toughness capable of resisting extreme tension without permanent stretch; great strength in proportion to weight and bulk; and resistance to wear.

Silent chains are now available employing links of as small as $\frac{3}{16}$-in. pitch.

Couplings

A development in flexible couplings has been made in so-called "starting couplings." The driving motor starts at high speed. Gradually the coupling grips the shaft of the driven machine, permitting a smooth take-up of load. These devices are available for both belt and direct drive.

In one such coupling, introduced from Sweden in 1930, a winged hub, attached to the driving shaft, revolves inside a cylindrical housing attached to the driven shaft. There is no direct connection between the two members. Power is transmitted from one to the other by a steel powder which partly fills the annular space between them. In operation, the powder forms in drifts ahead of the wings, and, by centrifugal force, the density of these drifts is increased to a point where the friction on the corrugated surface of the housing is sufficient to hold the two members together. An American manufacturer, following this design, uses chilled shot instead of powder. Water or mercury is used in other designs.

Another type of flexible coupling consists of two cut-tooth sprocket wheels (or coupling halves) and a piece of chain wrapped around their peripheries. Working surfaces are accurately machined.

Bearings

Refinements have characterized bearing development. From time to time manufacturers have announced new types featuring improvements in alignment and thrust-taking.

One innovation has been the use of synthetic resin in bearings, making possible the use of water as a lubricant. One type is made from a textile material impregnated with synthetic resin. It is said to be resistant to most acids and non-absorbent as to oil and water. Such bearings cannot be softened by heat, but are attacked by hot caustic alkalis.

A phenolic resin material is used to line a roll-neck bearing for applications where pressure is not excessive and the peripheral speeds range from 100 to 1,000 ft. per min. Here, also, water is used as a lubricant. The lining resists the action of weak acids and alkalis, as well as sand, grit, and scale in the lubricating water.

Lubricants

Modern automobile engine design has called for the introduction of oils having higher resistance to oxidation and higher temperature stability. These find wide industrial application. Diesel engine lubricating oils of high oxidation resistance, and of a higher degree of purity, as affecting centrifuge operation and carbon deposition, have been developed.

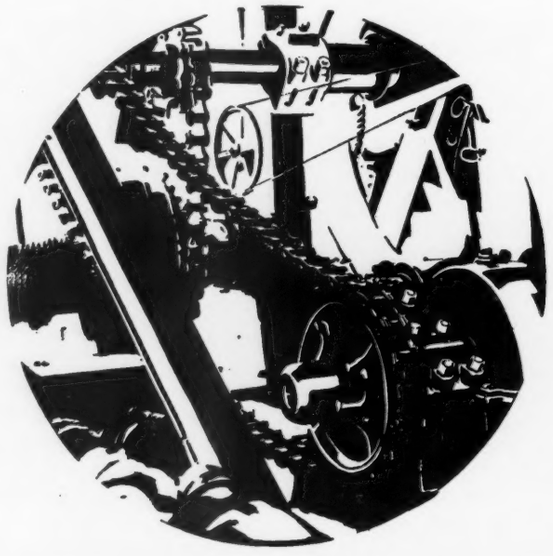
For applications involving high temperatures, a colloidal-graphite castor oil has been developed, as well as a colloidal-graphite glycerin for low temperatures.

A lubricant for diesel engines has been introduced for which reduction in carbon formation and ring-sticking is claimed.

Special oils have been developed for over-loaded and heavily loaded gears that cannot be lubricated with straight mineral gear oil.

A lubricating material intended to plate the bearing, was developed abroad and is now available here. Its action is based upon the theory that there are minute electrical discharges between the working parts. The lubricating material has the function of utilizing the electric discharges to cause an extremely thin film of metallic zinc to be deposited upon the wearing surfaces. The manufacturer claims effective prevention of pitting and wear. The lubricant is available as a fluid or non-fluid.

Recently introduced, a colloidal graphite motor lubricant may be had in a concentrated extract to be added to regular lubricating oil. The manufacturer explains the action of this lubricant by saying that the minute particles



of colloidal graphite possess a very high adhesive power toward metallic surfaces, and because of their minute size penetrate and fill up microscopic crevices in them; that under the actual work of frictional members they form a highly polished surface of graphite without disturbing the bearing alignment and clearance; and that bearings with graphitized surfaces have very small coefficients of friction, and may work at higher temperatures and carry higher bearing pressures than similar bearings without such a surface.

Lubricating Devices

Central lubrication has been expanded during the past three years. Automatic central lubrication systems can be built into the equipment. They comprise a small central pump, used in conjunction with a metering device, from which metal tubing delivers the oil or grease to the machine bearings. There are available systems capable of delivering automatically a definitely metered quantity of lubricant suited to each bearing need.

Completely automatic centralized systems of lubrication, fully adjustable, are available, capable of handling practically any type of lubricant. Minute quantities, determined by accurate adjustments, can be delivered indefinitely. The metering device is usually an adjustable, constant-displacement pump, driven from the machine to be lubricated. Sight indicators may be incorporated to permit observation of the operation of all valves at all times. The main pumping device is also usually operated by the machine to which it is applied, starting and stopping with it. Ingenious cam designs, which impart oscillating as well as reciprocating motion to the plungers, obviate the need for valves.

One pump available, which occupies with its reservoir a station only 5 in. in diameter by 6½ in. high, will lubricate as many as 75 bearings with any desired frequency from 2 to 30 minutes.

Another development has been the high-pressure lubricator for special installations in the chemical and allied industries. It supplies lubrication against pressures as high as 50,000 pounds.

In a typical single-line system for the mechanical application of light greases and heavy oils, the main unit is placed in a convenient location and a single feeder line is taken to the farthest point requiring lubrication. Branch lines are taken from the main line at each bearing. No return line is required. An independent mechanical measuring unit, placed at each bearing, allows only the amount of grease it is set for to be fed to the bearing. By means of a positive pump, pressure is applied to the line only when the points are being lubricated. The unit can be operated by motor, mechanically, or by hand.

Less elaborate devices than those just mentioned are available and give extremely satisfactory operation in the class of service for which they are suited. Thus, an automatic, electrically operated oiling system, for use with industrial machinery, is provided with an oil tank that is equipped with a heating unit separated from direct contact with the oil. The heater unit is energized when the machine to be lubricated is started. The heat raises the temperature of the oil, and the resulting expansion forces the oil out of the tank to the bearings, where suitable metering devices control the flow. After the temperature has reached 150 deg. F., a thermostat breaks the circuit and the oil is allowed to cool to 100 deg. F., at which temperature the thermostatic switch again makes contact. During the cooling process a vacuum occurs which is utilized to refill the tank from a central supply.

Simpler systems may be had which make use of adjustable-wick oil-feed units, with no moving parts. They provide continuous control over quantity of oil fed each bearing, regulating the lubrication of several bearings on a machine. Adjusting the height of the turn-down of each wick loop determines the quantity of oil fed by the wick, the oil level in the wick chamber being constant.

Other multiple oilers are available which automatically lubricate any number of bearings at any desired interval. Oil cups rise out of a well of oil at fixed intervals and drain by gravity through their corresponding outlet tubes. They may be actuated pneumatically, electrically, mechemically, or manually. Timing control is provided.

[Next month's article will summarize the principal developments in Electrical Distribution Equipment.—Ed.]

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No More Costly Shutdowns With This Modern Power Transmission

CONTINUOUS operation, lower power costs, and a better product may be cited as major advantages resulting from the change-over to electric power drive at the Buffalo Flour Mills Company, Buffalo, N. Y. The change was made in June, 1932, and at the present rate will pay for itself in considerably less than two years' operation.

Prior to that time, all but a small portion of the connected load was supplied by a 500-hp. cross-compound two-cylinder steam engine revolving at 115 r.p.m. direct-

connected to the main drive shaft. This main shaft was, and still is, connected to line shafts on the second and third floors by manila rope drives. A hammer mill, the flour packers, feed packers, sewing machines, and three grain elevators were then, and still are, electrically driven.

Steam was supplied to the engine at 175 lb. by two 300-hp. boilers equipped with underfeed stokers. One chief engineer, two assistants, and three firemen were needed to operate the power house.

This drive proved unsatisfactory on a number of counts. Several times during the year preceding the change there were shutdowns lasting from 12 to 24 hours caused by a blown-out boiler tube or a burned-out bearing. These shutdowns were unusually serious because profitable operation of this mill is dependent upon continuous operation 24 hours a day.

Moisture caused by evaporation and condensation of steam and by the sweating of pipes provided the second count in the indictment of this installation. The moisture was absorbed by the flour, and that meant prolonged drying operations.

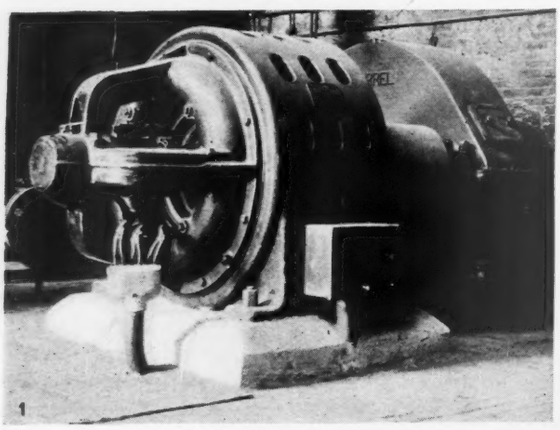
Again, uniformity of process and product was not assured. At best, the steam plant varied from the standard of 115 r.p.m. There were also variations in pressure and torque, and all these things were reflected in the processing and hence in the quality of the product.

That was not all. Power was too expensive what with the chief engineer, his two assistants, and the three firemen, not to mention the high cost of fuel and the always increasing expense of keeping the equipment in good working order.

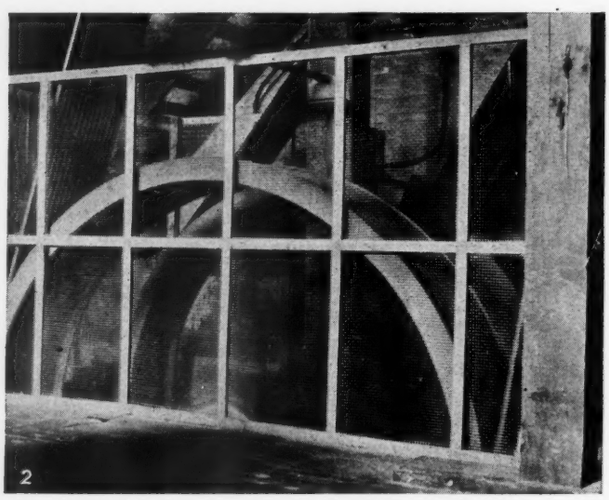
The upshot of the matter was that the boilers and the engine were sold, and in their stead the company purchased a three-phase, 25-cycle, 730-750 r.p.m., 2300-volt, 600-hp. motor direct-connected through a flexible coupling to a herringbone-gear speed reducer. The latter is connected in turn through a flexible coupling to the old drive shaft, which is driven as before at 115 r.p.m. From this point on power is transmitted as before. One small boiler supplies steam for heating purposes, and one man runs it.

Result: Except for one brief shutdown during a severe storm, the equipment has operated continuously 24 hours a day since installed. Because of the absence of steam (except what is used for heating in winter) the flour picks up relatively little moisture. No protracted drying operations are necessary. Power costs less than it used to. Maintenance expense is much lower. The product is more uniform.

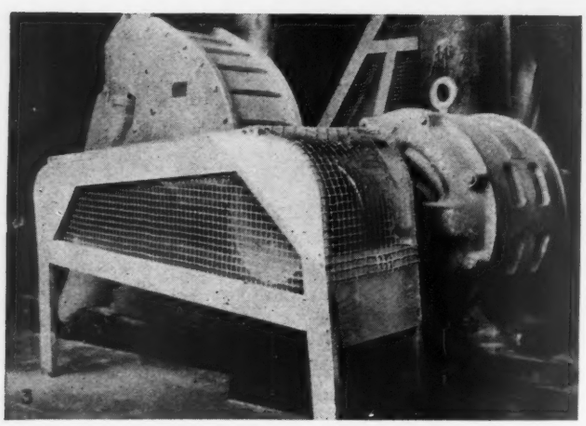
All in all, the present set-up is the well considered combination of individual and group drive in which so many plants have found the right answer to their power transmission problem.



(1) All but a small portion of the mill load is now driven by a 600-hp. motor connected by a flexible coupling to a herringbone-gear speed reducer which in turn drives the main shaft through a flexible coupling. This installation has proved much more satisfactory than the steam-engine drive formerly in use



(2) Power is transmitted from the main drive shaft to lineshafts on the second and third floors through two manila rope drives, one of which is here illustrated. No change was made in this part of the installation



(3) Certain machines were formerly, and still are, individually driven. This hammer mill, for instance, does heavy duty, wears rapidly, must be frequently shut down for repairs. The advantages of the individual motor for this type of service are obvious

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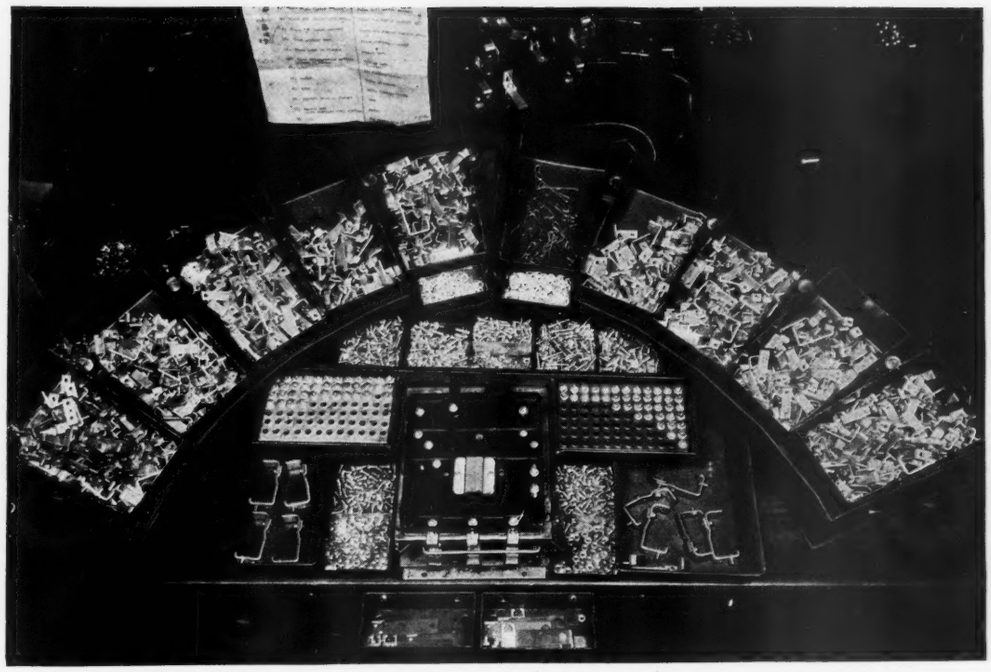


Figure 2

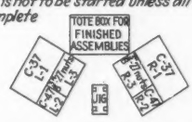
How Are You Going to Train Your New Operators?

Don't take your best men off production to train green help; the process chart offers a quicker, cheaper, and better way

Allan H. Mogensen
Consulting Editor

INSTRUCTION SHEET FOR ASSEMBLING

PART NO: P.I. 159
DRAWING NO: P.I. 159 DEPT. "B" Shop
NAME: Mounting Stud for Recorders
OPERATION: Assemble X.O.1
TOOL REQUIREMENTS: Assembly Jig
REMARKS: Material to be received in four trays. Work is not to be started unless all material is complete



Motions	
Left Hand	Right Hand
1 To L-1	1 To R.1
2 Grasp stud (C-37)	2 Grasp stud (C-37)
3 To jig (upper end)	3 To jig (lower end)
4 Assemble to jig	4 Assemble to jig
5 To L-2	5 To R-2
6 Grasp washer (C-47)	6 Grasp washer (C-47)
7 To jig (upper end)	7 To jig
8 Assemble to upper C-37	8 Assemble to lower C-37
9 To L-3	9 To R-3
10 Grasp $\frac{3}{8}$"-27 nut	10 Grasp $\frac{3}{8}$"-27 nut
11 To jig (upper end)	11 To jig (upper end)
12 Assemble nut to C-37	12 Assemble nut to C-37
13 To L-3	13 To R-3
14 Grasp nut	14 Grasp nut
15 To jig (lower end)	15 To jig (lower end)
16 Assemble nut to C-37	16 Assemble nut to C-37
17 To assembled P.I.159	17 To assembled P.I.159
18 Grasp assembly	18 Grasp assembly
19 To tote box	19 To tote box
20 Drop in tote box	20 Drop in tote box
Actual time-.45 min.	Allowed time-.50 min.

Figure 1

THERE is no question about it. Industry is up against more problems today than it has ever before had thrown in its lap at any one time. Codes, policies, price-fixing, industrial grouping, representation—many of these are new. All are the result of the National Recovery Act and the President's Reemployment Agreement—"a part of a nation-wide plan to raise wages, create employment, and thus increase purchasing power and restore business." And there is no doubt that employment is increasing. New figures prove this daily.

Which brings us to the part of the problem that has been passed on to the plant manager. It is true that he has been having a few busy weeks bringing wage scales into line, adjusting rates, determining new incentive policies, but the most pressing and bothersome question is without a doubt that of training new workers. A recent trip through the East and South shows that in many plants large groups of new and unexperienced workers have been taken on, and the problems incident to turning out considerably increased production leave but little time

Figure 3 *Photographs by courtesy of Westinghouse Electric & Mfg. Company*

OLD METHOD—The bushings were dumped out on the inspection table. The operator picked up a bushing for each individual inspection operation. The process chart shows that this meant handling each bushing twice, and using the hand as a holding device during most of the cycle. Time values shown on the chart are in decimal hours

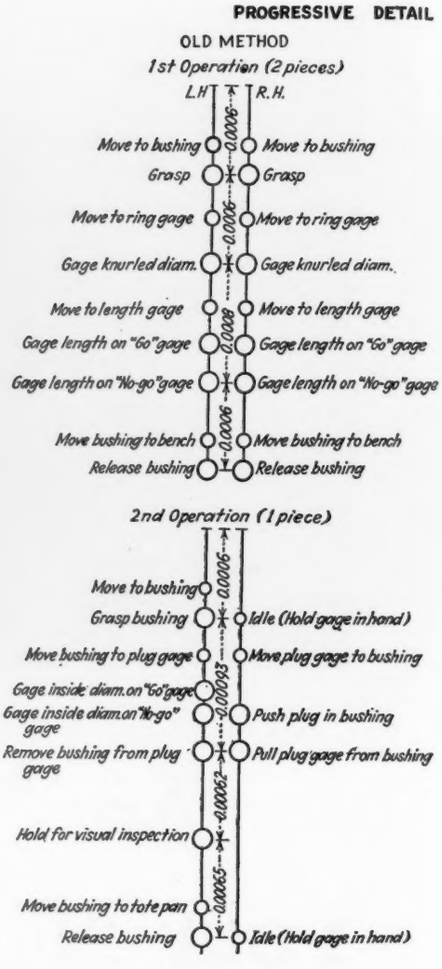


Figure 4

for the job of training them to become good operators.

The usual procedure, therefore, is to take the new worker to the department, and after some instruction from the foreman, he either works it out as best he can by himself, or is turned over to one of the regular operators. And while there are many people who can do a certain job well, few can teach others to do the same.

Several plants have for some time been using the Gilbreth process chart for instruction. Others that have been using it to analyze and improve methods have found it of inestimable value at this time for training. It is a simple and easy tool to use—and it is not too late to start

As pointed out in "The Process Chart—indicator of profitable changes" (June, 1933, page 214), process charts are part of management's measuring tools—without which management's guesses will be as costly as the guesses of workmen. For no definite or permanent advance is made in any kind of work, whether with materials or men, until use is made of measurement. The charts described in this article were of the "flow" and the "man and machine" type. For purposes of instruction, these are usually amplified by the "operator" chart, or "right-and-left-hand" chart. Such a chart is illustrated in Figure 1.

This chart is typical of those used by a manufacturer of electrical measuring apparatus, and its value is emphasized inasmuch as his runs are short and not of frequent recurrence. It would be impossible for the foreman or time-study man to devote his time to supervising every one of these set-ups—seeing that material was properly placed, tools correctly located in order that the job be performed correctly, in the shortest time, and with the fewest motions and least fatigue. And it is common knowledge that few operators, unless they have been trained in principles of motion economy, ever pay attention to these points.

Realizing this, this concern began some time ago to make up simple instruction sheets in process chart form. When the operators secure the materials and tools for the assembly or operation, they also draw out standard parts containers as called for on the process chart that accompanies the drawing or work order. It is then a simple matter to follow through once or twice, slowly, according to the instructions, until the correct method has been mastered. After that speed is soon acquired.

This practice not only secures proper performance on each job done, but soon starts the workers thinking along lines of motion economy. As a result, suggestions for improvement of existing methods as well as on new jobs are received. If you can once capture the interest of the operator, it is surprising to see the valuable ideas that will be forthcoming. As one operator said, when given a process chart for instruction: "I like this. It is swell knowing exactly how the job should be done. Before, everybody was telling us, but nobody really knew."

These process charts are not confined to such simple jobs as the one illustrated above. Figure 2 shows how another company uses the right-and-left-hand process chart. It is placed directly in front of the operator on this

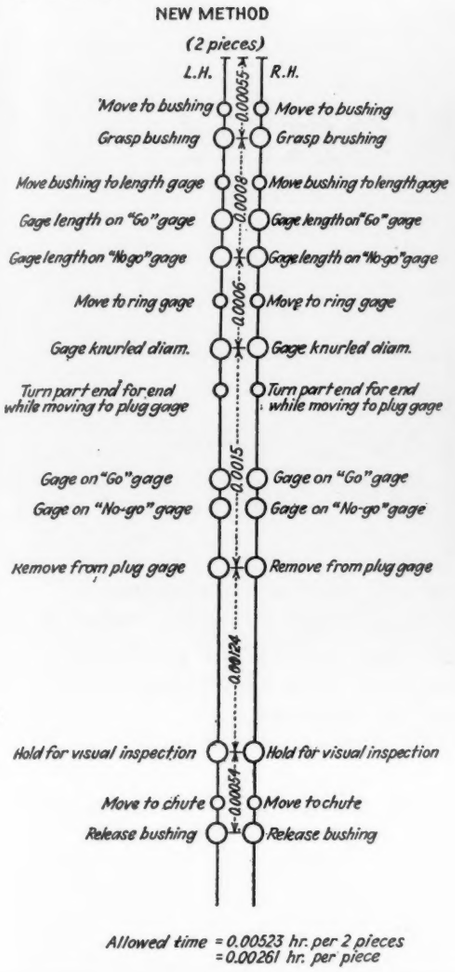


Figure 5

NEW METHOD—A slide is arranged to feed bushings to one point. Two pieces are now inspected at the same time, and both hands work and rest simultaneously. Drop delivery is made through the holes in the bench. The operator is now seated in a comfortable chair; fatigue has been greatly reduced; and a 68 per cent reduction in time secured

operation, considerably more complicated, but yet so arranged that even a new operator can soon develop the proper sequence of motions. As a result of common-sense motion study, a reduction of 60 per cent in assembly time was secured. The circular bins are so arranged that all the work is within the maximum working area, keeping the body in balance and reducing fatigue. The piece is ejected by a foot-operated lever.

In another plant a very elaborate and delicate operation was set up along the same lines. Principles of motion economy were applied, and a right-and-left-hand chart drawn up. There are 80 operations with the left hand, 91 with the right, assembling 44 different parts, and yet they are so simply and clearly described by this method that new operators are being started out on the operation with the process chart. Incidentally, the new method will take between 4 and 5 minutes, as against 45, and the quality will be materially improved.

Figure 3 shows the old method of inspecting a Chevrolet gear bushing. The new method is illustrated in Figure 5; Figure 4 shows the process charts for both old and new methods, and indicates the change from one piece per cycle to two pieces, with a resulting reduction in time of 46 per cent.

It is not an uncommon occurrence, even when a time standard is properly and fairly set, to find operators failing to make it. The man who set the standard based it on the assumption that the operation would be performed in the correct manner. Failure to write proper instructions, to follow through and see that these instructions are carried out, or reversion to older methods as time and force of habit have their effect, may be responsible. If process charts are made before time studies—as they always should be; otherwise poor methods may be perpetuated—elemental values may be tied in as shown on Figure 4. This failure to come up to standard may be checked by the time-study man, and the points of difficulty remedied.

One more point where the value of the process chart method is emphasized. Many concerns have several plants performing similar operations. In an effort to keep away from seeming dictation as to detailed methods, the management has often left the details up to each plant manager. Even though time standards and performance records are available, each plant usually feels that there are certain reasons why its methods or results differ. Putting these down in process chart form enables direct comparison, points out the differences involved, evaluates these differences, and then sets up the new method that fits the needs and conditions of the various plants. All the plants thus benefit.

To sum up, process charts pay. They develop a questioning attitude that considers the good of the plant rather than that of a department or individual. They indicate the best type of operator and equipment needed, determine when the work can be most economically performed, even out the flow of work, eliminate unnecessary effort, and point to further improvements. As a training tool, and a rapid one, they are unequaled.

J. Jones, Foreman— What's His Job Worth?

Howard Tilson

Industrial Engineer, A. G. Spalding & Bros.
Chicopee, Mass.

THERE have been many schemes advanced in recent years for putting various groups of labor within a plant on an equitable pay basis. However, when it comes to foremen and assistant foremen in those plants where a bonus plan is in effect, we find more or less chaos. Many a foreman's salary, like Topsy, "just growed," with the result that we find foremen of long service but light responsibilities receiving more than men of shorter service but considerably heavier responsibilities. The introduction of any bonus or premium plan tends to aggravate this condition, often with a bad effect on the supervisory morale.

To overcome this, a certain manufacturer evolved the following plan of evaluating the foreman's job. No claim is made for perfection, yet the results in practically every case were in line with the opinion of the executives as to the worth of the job, and at the same time offered a specific basis for the resulting adjustment in the figuring of net premium.

The underlying theory on which the scheme was based, is that foremen having equal responsibilities should receive the same *net pay* during periods of normal operation, regardless of length of service. By net pay is meant salary plus bonus or premium.

Loyalty as represented by length of service is worth added compensation, and in times of slack production, shutdown, or sickness, the foreman with years of service will benefit by virtue of a higher actual salary.

The actual working of the plan is best illustrated by the following example. Let us assume two foremen of equal responsibilities who attain the same results according to whatever measuring stick is in effect. One gets $35 per week; the other by virtue of several years' longer service or a more aggressive attitude in asking for more money gets $40 per week. If the premium or bonus for the first man figures $10, giving him a net pay of $45, then the second foreman should receive a *net* premium of only $5 resulting in a net pay of $45 also. This is based on the assumption that the inherent value of the jobs in question is worth a base salary of $35 per week.

In order to arrive at the relative responsibilities involved in the various supervisory jobs, those items were listed which should be taken into consideration in judging the qualities necessary to fill a foreman's job in a given department. After due consideration, the list shown in Figure 1 was established as best fitting the needs of the plant in question. It might be inadequate in some industries.

POINTS TO CONSIDER

IN EVALUATING J. JONES'S JOB

1. Number of people supervised
2. Trade knowledge or skill required
3. Number and variety of operations
4. Number and size of orders
5. Number of set-ups
6. Quality factor

Figure 1

This list is more or less self-explanatory. (1) We are all agreed that responsibilities and duties increase with the number of employees, although this factor in itself does not represent the entire picture. (2) Certainly a job requiring a background of trade knowledge should pay more than that supervising relatively unskilled labor. (3) A foreman's job is complicated by virtue of a wide variety of operations and is worth more from this angle than one wherein the operations are few and continue day in and day out. (4) A department operating on few orders of large numbers of pieces is easier to handle than one which is constantly flooded with a large number of orders, particularly if the orders call for a few pieces each. (5) This in turn brings up the question of set-ups; such a situation consisting of a large variety of operations, coupled with a variety of pieces made, coupled again with a small number of pieces, involves a continual change of set-ups, which necessarily increases the complications and responsibilities connected with the job. (6) A man supervising the assembly of a calculating machine has much more of a quality factor tied up in his job than, let us say, the foreman of the shipping room.

The next step, which should possibly apply only in a large plant with a variety of products, was to divide the foremen, 31 in all, into three groups:

1. General department foremen, foremen of large rooms, or key foremen.
2. Foremen of medium-sized rooms.
3. Foremen of small-sized rooms.

It was felt that if all the foremen were placed in one group and their jobs judged according to the above schedule, it would work an injustice due to the wide

Figure 2

HOW J. JONES GOT HIS RATING

Number of Operations	Skill Required	Variety of Operations	No. & Size of Orders	No. of Set-ups	Quality Factor
55	100	100	75	50	100

Total Score	Per Cent	Total Value	Amt. to Add	Base	Net Pay	Suggested Rate
480	80	$12	$9.60	$40	$49.60	$50

spread between the largest and smallest departments both in number of employees and equipment.

The dividing lines were purely arbitrary. For example, while the average for the medium-sized departments ranged from 12.7 operators to 74.9 operators, the large-room foremen supervised from 24.4 to 44.9 men and the general foremen from 59.1 to 99.1 operators.

Basic wages for each group were then set at $40, $28, and $25 per week.

Returning now to the six factors, equal weight was given to each—i.e., a value of 100 points, giving a perfect score of 600 points. This perfect score was assigned an equivalent money value of $12 for Group 1 and $9 for Groups 2 and 3. By dividing each man's score of 600 and multiplying by the foregoing money value, we arrive at the amount to be added to the basic wage, the result being his base wage or rate for purposes of figuring premium and net wages. Figure 2 gives a typical example.

The rating for Factor No. 1 was established arithmetically. The foreman within the group having the fewest number of operations was rated 0. The one having the most was rated 100. Those in between were rated proportionately. Example: *A* has 59 employees and is rated 0; *B* has 99 employees and is rated 100; *C* has 81 employees. The difference between the maximum and minimum is 40; *C* has 22 more than *B;* his rating would be 22/40 of 100, or 55.

Other factors were rated arbitrarily according to the best judgment of the executive committee, keeping in mind that it was the *job* that was being rated and not the *man.* Figure 2 also shows how J. Jones received his rating of 480 points.

When the entire list was completed, as far as the theoretical base rates were concerned, the rates were reduced to round figures as shown in "Suggested Base Rate," foremen having theoretical base rates nearly alike being assigned the same rate.

It is felt that this plan is simple and understandable, and can be easily explained and sold to a supervisory force as fair and equitable.

▼ ▼ ▼

Stop No-Load Transformer Losses

Says Ray Stroppel

Maintenance Engineer, The Tool Steel Gear & Pinion Company
Cincinnati, Ohio

His concern spent $136 for three single-phase motors that are operated from a 75-kva. lighting transformer, did away with the need for three-phase power during no-load periods, saves $284 a year because now it shuts down its three 200-kva. power transformers during holidays and week-ends

POWER used in our plant is purchased from the local utility company at 13,200 volts and reduced to 220 volts by the use of three 200-kva., oil-cooled transformers that are closed-delta connected. These transformers are used for power only; light is furnished by a separate 75-kva. transformer.

The power transformer bank is controlled independently of the lighting transformer by a 13,000-volt oil switch, making it possible to shut off all current flowing into this bank and at the same time have light.

The current and potential transformers for metering purposes are on the primary or high-voltage side of all transformers and oil switches. This type of installation is available to users of current in large blocks with a minimum demand of 300 kw. based on a 15-min. interval.

The advantages of this type of metering are:

1. Low cost per kilowatt-hour.
2. A very reasonable demand charge.

Its disadvantages are:

1. Ownership of all transformer equipment.
2. Maintenance of all transformer equipment.
3. Consumer pays for all transformer losses.

The advantages, however, have more than repaid us

in savings made each month on our power bills. The method allows us to take advantage of the best rate we can get.

With the thought in mind that "the consumer pays for transformer losses," we took the following steps to reduce them to a minimum.

The losses of our 600-kva. bank of transformers for a period of 42 hours each week-end when the entire load is off the line are shown in Figure 1 as "Summer Losses"

Week-End Losses

Summer

Loss per hour	6 kw.
Number of hours (26 week-ends)	1092
Kilowatt-hours	1092 × 6 = 6552
Cost per kilowatt-hour	$0.0175
Loss for six summer months	$0.0175 × 6552 = $114.66

Winter

Loss per hour	6.5 kw.
Number of hours (26 week-ends)	1092
Kilowatt-hours	1092 × 6.5 = 7098
Cost per kilowatt-hour	$0.0175
Loss for six months	$0.0175 × 7098 = $124.12

Figure 1

and "Winter Losses." The reason for this method of computing the total loss per year is that during the winter months there is a small load of about 6 kw. used for motors and pumps in the heating plant.

With about ten additional shutdowns each year due to holidays, we have more no-load losses to account for. These holiday losses are grouped into one sum, and are

Total No-Load Losses

Holidays	$45.93
Summer week-ends	114.66
Winter week-ends	124.12
	$284.71

Figure 2

shown in Figure 2 added to the week-end losses to make a total of $284.71.

The losses listed per hour in the summer months are transformer core losses alone, the additional ½ kw. losses per hour for winter months are copper losses, caused by the use of a small load in winter only.

With our lighting transformer operating independently of the power bank, it was simple and inexpensive to replace the three-phase, 220-volt motors on our heating plant boiler and pumps by 220-volt, single-phase, repulsion-induction-type motors than are fed from the lighting circuits. By this small change of only three motors we had no further need for three-phase power in the plant on week-ends or holidays. Each week, after the plant has stopped operations, the main 13,000-volt oil switch is opened, cutting off all current from flowing through the 600-kva. power bank, thereby stopping all core and copper losses in the transformers. In winter when the heating plant is in operation, the motors that are needed are run from the lighting transformer.

The entire change-over including motors, supplies, and labor amounted only to $136. We utilized all old conduit circuits and control equipment. Since this plan of operation has been in force the savings already made have paid for the installation. Though small, they will continue as long as we are on our present rate contract.

This type of loss, incidentally, is one of the many losses that are going on every day in industrial plants that use electricity in one form or another. If the electrician in charge will only spend more time in analyzing his own particular plant and load, he can save his company more money each year than his salary amounts to. The important thing for the chief electrician to remember is that he must be able to present a money-saving idea to his management in an understandable manner. Many a good idea is lost to the man and to the industry through a misunderstanding of what the practical man is trying to put across.

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Hours, Earnings—1926, Now

NEED FOR extensive wage readjustments is indicated in an analysis of average weekly earnings and average hours of unskilled male labor in 1926 and in May and June, 1933, made by the National Industrial Conference Board, Inc., New York, N. Y. While earnings of unskilled male workers in 21 major manufacturing industries increased from $14.42 in May to $15.83 in June, they were still considerably below the 1926 level of $23.22.

These data have a direct bearing on questions arising out of the minimum wage regulations established under the various codes of fair competition. Where average earnings are below, or not much above, $14 per week, it is evident that it will be necessary to increase the wages of a large proportion of the unskilled male workers to enable them to earn $14 in a 35-hour week, which is the minimum standard set by the President's Reemployment Agreement. Furthermore, where the average weekly earnings are relatively high, these data indicate that in most instances average hours worked exceed the proposed 35-hour week. Application of the 35-hour limitation would require a fairly general increase in hourly rates to produce a weekly income of $14; even a 40-hour limitation would involve an upward adjustment of wages in several important industries, including the northern cotton industry.

In May, 1933, average hours were less than 35 in only 5 of the 21 industries included; in June the average was above that level in every industry. Although average weekly earnings were uniformly below the 1926 level, the average number of hours in June nearly reached the 1926 average in several cases and actually exceeded that average in four industries—namely, the northern cotton, hosiery and knit goods, meat packing, and wool industries.

If earnings of workers now receiving less than $14 a week are increased to that level, and if weekly earnings of other workers are maintained at present levels, the general introduction of the 35-hour week will result in a considerable increase in average hourly earnings and in the labor costs of manufacturing industries.

Maintenance Cost Control

IV—Control by Ratio to Production Cost

W. C. Zinck

Head of Standards, North & Judd Manufacturing Company
New Britain, Conn.

THE METHOD to control maintenance costs through a ratio to a productive factor embodies this principle—for each unit of the productive factor a definite amount of money is allotted to be spent on maintenance during a specific period, and if the money actually spent does not exceed the allotment, the performance of the maintenance division is considered satisfactory.

The theory underlying this principle is that, inasmuch as the money for the maintenance work comes from the productive work, the amount of maintenance work done should be kept in line with the volume of productive work done. The major limitation of this theory arises when productive work is at a subnormal level. When it is, the maintenance allowance is reduced, whereas the amount of maintenance work to be done does not decrease proportionately—in fact, items like steam, air, and water lines deteriorate more in disuse than in use.

The productive factor to be used depends, of course, upon the type of work done. A company making one type of product could set the maintenance allowance at so much per unit produced, while a company doing diverse manufacturing could make its maintenance allowance a certain percentage of the productive payroll, or of the productive hours.

A plant employing 2,100-2,300 employees on machine work, heat treating, and small assembly work, has devised an exceedingly close control of maintenance costs based on the productive hours. Each of the non-productive departments, including the maintenance department, has a ratio established for it. Each morning the head timekeeper prepares a report of the total productive hours to be worked that day and presents it before 9 a.m. to the general manager, and to each department head affected. Each maintenance foreman takes the total productive hours, multiplies it by his ratio to obtain the total hours his department can work. He then checks the number of his men at work, and makes the necessary adjustments to conform to his allotment.[6]

Another manufacturing company of diverse articles bases its maintenance quota, as it is termed, on the productive hours, but not in direct proportion. Curves are developed for each maintenance subdivision with productive costs as the base.[7]

A company manufacturing tires uses a ratio of tires per man per day as an indirect means of reducing its maintenance costs. The plant engineer is one of thirteen men who share in a supervisory bonus based on this ratio. By keeping maintenance costs down and making plant improvements (the larger function of preventive maintenance) he earns a substantial bonus.[8]

A paper company set its ratio for maintenance cost in its maintenance control system by taking the average for the past five years of the maintenance cost per unit of output. The ratio was set to effect a reduction of 15 per cent in maintenance costs, taking into consideration changed conditions and lower costs for labor and materials.[9]

A steel company set its base or maximum maintenance cost on the performance during the eighteen months previous to the installation of the control system to arrive at the maintenance cost necessary to produce one ton of steel.[10]

A paper company had an industrial engineer develop a budget for its mechanical department based on the cost per 100 points, or standard minutes.[11]

In the use of the ratio method, or any other method of control, due allowance must be made for extraordinary repairs, rearrangement of departments, or large installations. Such work should be covered by special appropriations. Also, the ratio method of control does not interfere with the operation of a reserve for maintenance if such a reserve is set up to cover certain specified items like painting and similar work, which can be postponed to periods when the shop is not working at full capacity.[7]

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[6] "How Control Non-Productive Costs?" Harry W. Benton, Plant Engineer, The Pratt & Whitney Company, Hartford, Conn., *Industrial Engineering*, November, 1930 (pages 569-570).

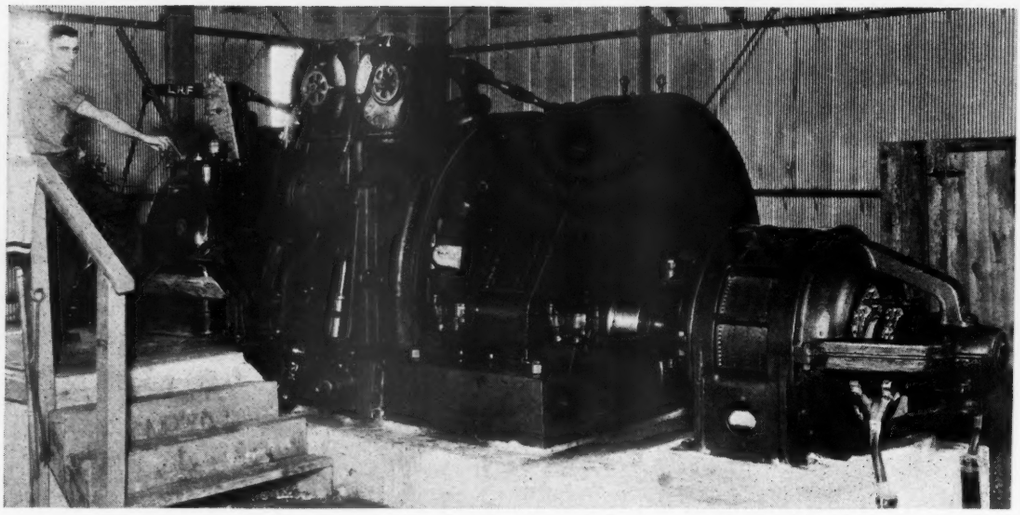
[7] "How Measure the Efficiency of the Maintenance Department?" J. W. Merson, Superintendent of Power and Plant, The Yale & Towne Manufacturing Company, Stamford, Conn., *Maintenance Engineering*, November, 1932 (page 434).

[8] "Maintenance Reduces Costs, Helps Restore Pay Level" at the India Tire & Rubber Company, Mogadore, Ohio, John W. Shaver, Contributing Editor, *Maintenance Engineering*, September, 1932 (pages 359-360).

[9] "Budgeting Upkeep Keeps Down Expenses," B. A. Franklin, Vice-President, Strathmore Paper Company, Mittineague, Mass., *Industrial Engineering*, December, 1929 (pages 622-623).

[10] "Wage Payment Modernization," Fred W. Acker, Assistant Superintendent, Electric and Power Departments, Inland Steel Company, Chicago, Ill., *Maintenance Engineering*, July, 1931 (pages 358-361).

[11] "Nashua Gummed & Coated Paper Company, Nashua, N. H.



Characteristics of the wound-rotor induction motor are well adapted to mine shaft hoist service. This motor is rated 100 hp., 450 r.p.m., 440 volts, three-phase

To Help You Choose Your A.C. Motors

A. A. Merrill

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SELECTION of a motor that has the proper balance of characteristics for a given application is complicated by the fact that a number of types are available. In order to simplify matters, the factors or characteristics to be considered have been listed at the head of the vertical columns in Figure 1. Each of the curves connecting points on the columns represents one of the following types of motors:

1. Squirrel-cage induction motors.
   - (*a*) Low-slip (low-resistance-rotor) types.
     - Normal torque, normal starting current (general purpose).
     - Normal torque, low starting current (high-reactance rotor).
     - High starting torque, low starting current (high-reactance rotor).
   - (*b*) High-slip (high-resistance-rotor) types.
     - Continuous rated (punch-press type).
     - Intermittent rated (elevator type).
2. Wound-rotor induction motors.
3. Synchronous motors.

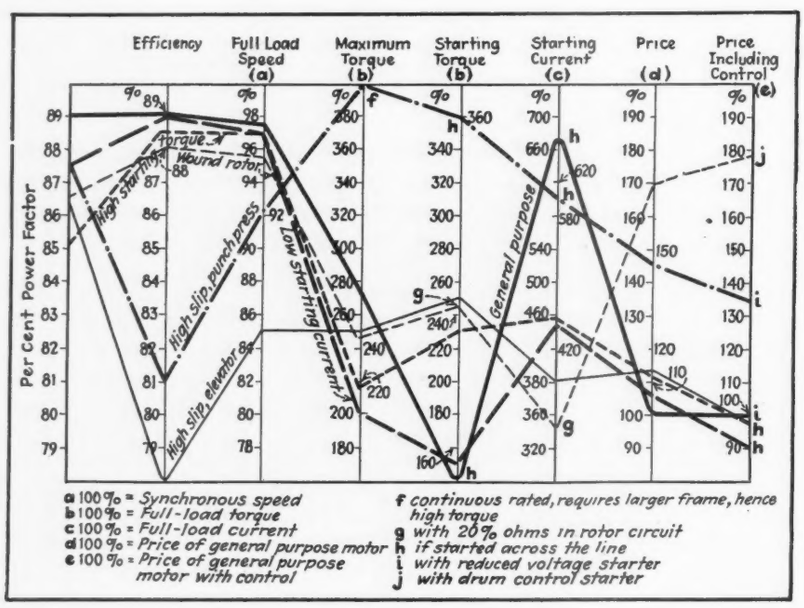

Efficiency
Full Load Speed (a)
Maximum Torque (b)
Starting Torque (b)
Starting Current (c)
Price (d)
Price Including Control (e)
Per Cent Power Factor
Torque
Wound rotor
High starting
High slip, punch press
High slip, elevator
Low starting current
General purpose
a 100% = Synchronous speed
b 100% = Full-load torque
c 100% = Full-load current
d 100% = Price of general purpose motor
e 100% = Price of general purpose motor with control
f continuous rated, requires larger frame, hence high torque
g with 20% ohms in rotor circuit
h if started across the line
i with reduced voltage starter
j with drum control starter

Figure 1. How typical, single-speed, three-phase, 30-hp., 1,200-r.p.m. motors of different types compare in characteristics. These curves do not apply strictly to all ratings

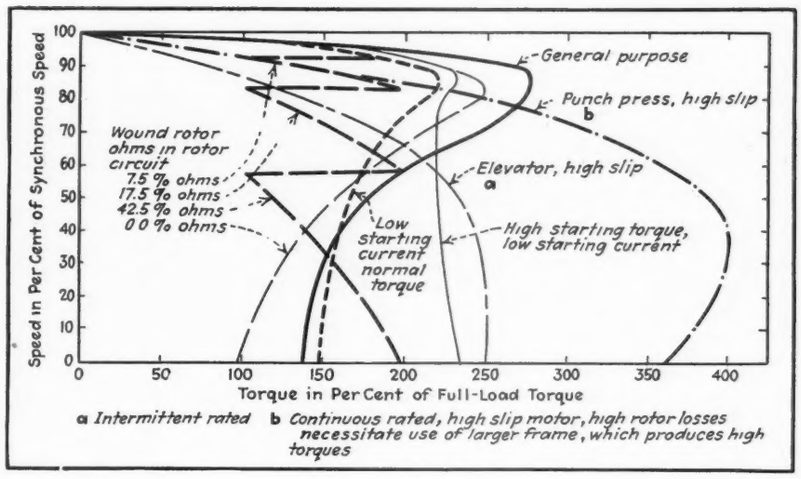

Speed in Per Cent of Synchronous Speed
Torque in Per Cent of Full-Load Torque
General purpose
Punch press, high slip
b
Elevator, high slip
a
Wound rotor ohms in rotor circuit
7.5 % ohms
17.5 % ohms
42.5 % ohms
0 0 % ohms
Low starting current normal torque
High starting torque, low starting current
a Intermittent rated b Continuous rated, high slip motor, high rotor losses necessitate use of larger frame, which produces high torques

Figure 3. Relation between speed and torque of wound-rotor motors and different types of three-phase, single-speed squirrel-cage induction motors

The synchronous motor is considered separately because its characteristics may be varied to meet certain requirements.

Before discussing the types of motors in more detail it may be well to consider the meaning and importance of the characteristics which Figure 1 lists.

Power Factor—The power factor of a load is defined as the ratio of real power in kilowatts to the kilovolt-amperes (kva.) demanded from the line.

Consider two plants, each with a connected load of 1,000 kw., the first plant having a power factor of 85 per cent, the second having unity. The first plant will then require 1,000 ÷ 0.85 = 1,180 kva., whereas the second will require 1,000 ÷ 1.0 = 1,000 kva. The feeder system for the first plant will have to have a capacity 18 per cent higher than that for the second, even though the actual power required by each is the same.

If a large, continuous-running motor is being considered, or a bank of smaller motors, the selection of a type having high power factor may effect appreciable savings in the power bill. Power factor is not so important in a crane or hoist motor that is operated intermittently.

All induction motors operate with a lagging power factor. In order to improve the power factor of a plant, a "leading" component of current may be supplied by capacitators or synchronous condensers. However, the most inexpensive way of supplying leading kva. is to use synchronous motors in place of large induction motors.

Efficiency—Defined as the ratio of the useful work done by a motor to the power drawn from the line. It is important if the motor is to operate for long periods. It is not so important as other characteristics for motors intermittently operated. The second column of Figure 1 shows typical relative efficiencies of induction motors. Synchronous motors are usually more efficient than induction motors, as Figure 2 shows.

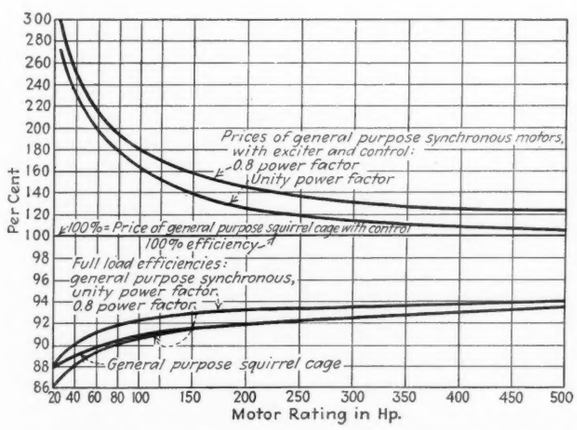

Per Cent
Prices of general purpose synchronous motors, with exciter and control:
0.8 power factor
Unity power factor
100% = Price of general purpose squirrel cage with control
100% efficiency
Full load efficiencies:
general purpose synchronous, unity power factor
0.8 power factor
General purpose squirrel cage
Motor Rating in Hp.

Figure 2. There is little to choose between the efficiencies of general-purpose synchronous and squirrel-cage motors, and as the ratings increase the disparity in price becomes less. These curves represent average figures for 60-cycle motors rated 600 to 1,200 r.p.m.

Full-Load Speed—Speed of induction motors tends to decrease slightly as load is applied, the difference in speed from synchronous to full-load speed being designated as "slip." Synchronous motors maintain absolutely constant speed, regardless of load, up to the stalling point.

A large drop in speed (high slip) may be desirable in certain applications. If a motor is used with a flywheel, or with a load having a flywheel effect, a drop in motor speed on the application of load is desirable, to allow the flywheel to deliver its energy.

Maximum Torque—Defined as the maximum torque that the motor will sustain without stalling. It is of great importance in applications having a widely variable load, with consequent torque peaks; also in localities where the voltage is subject to variations.

Starting Torque—Should be amply sufficient to break static friction and accelerate the load, but not high enough to damage gearing or throw off a belt.

Starting-torque requirements vary widely, ranging from a conveyor starting under load, and requiring a high starting torque, to a blower or fan which can be started with a low motor torque.

Starting Current—This characteristic should be considered in conjunction with the capacity of the system, and the requirements of the power company. Too high a starting current may blink lights connected to the same system, and lower the voltage sufficiently to stall other motors on the line. The current capacity of feeder cables, breakers, and transformers should also be considered. The limiting factor is the power system, since the motor windings may be braced for full-voltage starting, up to very large sizes.

Price—Should be balanced against the other characteristics; in many cases the advantages accruing from desirable operating characteristics will easily justify a higher price.

In comparing two motors for a given application it is often found that although one motor may be more ex-

pensive than the other, its cost complete with control may be lower. For example, a general-purpose, squirrel-cage motor may require a reduced-voltage starter to keep the starting current down, making it more expensive than a low-starting-current, squirrel-cage motor, which may be started on full voltage.

Types of Motors

General-Purpose, Squirrel-Cage Motor—This type of motor is very popular, because of its simple, rugged construction. No electrical connections are required to the rotor, so that slipring and brush maintenance is eliminated.

It is designed to fit the majority of applications and has good running characteristics ,with high power factor, efficiency, and maximum torque. Starting characteristics are not so good as afforded by some other motors—starting torque is low, and current is high—but they are favorable enough for most applications.

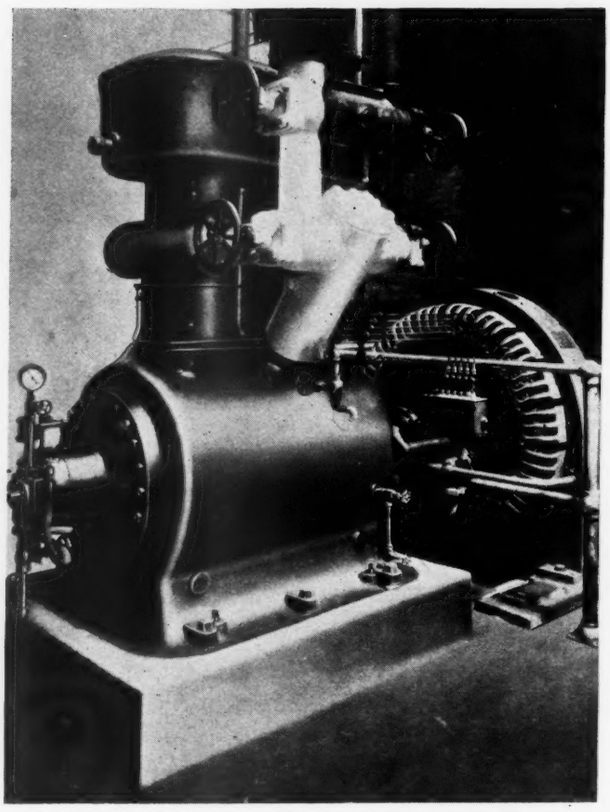
Normal - Starting - Torque, Low - Starting - Current, Squirrel-Cage Motor—Is often substituted for the general-purpose type, to permit full-voltage starting. A double-bar type of rotor is utilized to reduce the starting current. Running characteristics are similar to the general-purpose type, but power factor is slightly lower, and maximum or pull-out torque has been sacrificed materially. Starting torque is about the same as with the general-purpose type, started on full voltage. However, reduced voltage lowers starting torque considerably, so that the low-starting-current motor, starting on full voltage, will have an advantage over the general-purpose type started on reduced voltage.

High-Starting-Torque, Low-Starting-Current, Squirrel-Cage Motor—Designed to combine high starting torque with good running characteristics. It is usually substituted for the low-starting-current or general-purpose type in applications involving high starting torque and long periods of running with fairly constant load. Power factor and maximum torque are sacrificed, and efficiency is slightly lower. Starting current is practically the same as that of the low-starting-current type.

High-Slip, Squirrel-Cage, Continuous-Rated Type—Efficiency is comparatively low and starting current is high. It has a low full-load speed, slip amounting to 8 or 10 per cent of synchronous speed, an excellent characteristic for a flywheel, drive, or flywheel effect.

High-Slip Squirrel-Cage, Intermittent-Rated Type—Torque characteristics are high, compared with the general-purpose and high-reactance-type motors. The slip amounts to about 15 per cent; efficiency is poor, but is relatively unimportant because of the intermittent service. Starting current is low. The high torque makes rapid acceleration possible and the high slip minimizes power peaks. This type of motor should not be applied where running long periods at full load is involved.

Wound-Rotor Induction Motor—The rotor resistance is made variable by connecting the rotor windings to sliprings, which are connected through brushes to an external resistor. By inserting resistance in the rotor its characteristics become similar to the high-slip squirrel-cage motor, with low full-load speed, good starting torque and low starting current. As the motor increases in speed the rotor resistance is decreased until the rings are short-circuited at full speed. The motor characteristics are then comparable to those of the general-purpose, squirrel-cage motor, with fairly good efficiency and power factor, high maximum torque, and high full-load speed.



For driving compressors—the synchronous motor. Here is one rated 200 hp., unity power factor, 300 r.p.m., 4,000 volts

The external resistor gives good reversing (plugging) characteristics, which make this motor particularly applicable to accelerating and reversing duty, such as is found on cranes, hoists, and ore bridges. Also, the speed can be adjusted over a fairly wide range by varying the rotor resistance.

The first cost of the motor and control is higher than for the squirrel-cage type. Slipring maintenance is also added.

Synchronous Motor—The principal advantage from the use of this type lies in the saving in power bills. Its high efficiency and good power factor may easily justify the high first cost which is principally caused by the necessity for an exciter and special control. In low-speed drives, the synchronous motor becomes less expensive than the induction type.

A synchronous motor must be pulled into step at full speed; hence drives involving high inertia should be carefully checked to determine whether the motor has sufficient capacity to synchronize under load.

Maintenance required is a slight disadvantage since sliprings and an exciter are involved. This item is usually small, however, considering the savings effected.

Synchronous motors should not be used with flywheel drives nor with a widely varying load, unless special provision is made in the control to remove excitation during torque peaks. The principal field for this motor is on large drives, where savings in power bills offset the cost.

A Man in Overalls Looks At His Bosses

Here is a chance to learn what the man in the shop thinks about present-day relationships between employers and employees. The author is an engineer who got pinched in the depression. Two years ago he put on overalls, went to work in a Chicago stockroom, is still there. His early schooling in India and England, his study of industrial conditions in Continental Europe as an Oxford scholar, his ten years of engineering and sales experience in this country, combine to give him an exceptional background from which to observe employment conditions as the man who wears overalls sees them

THIS would seem an opportune moment to analyze some of the smaller matters in industrial organizations that mean so much to a worker and are perhaps lost sight of among the problems that we are accustomed to call "big" or "important." To an ambitious working man his career means everything. Although his interests do not extend to the larger problems, he surely has problems that are of vital interest to him, and every organization should be willing to give them consideration.

With the lessons taught us by the depression we have definitely come to a point where no industrial concern can afford to neglect its manpower, yet in all the organizations that I have been privileged to be associated with, there has not been a department looking after such matters. In some cases a personnel department has existed, but it was merely an agency for hiring help.

I assume that every industrial organization desires efficiency throughout and believe that such an ideal cannot be realized without a live personnel department. Briefly its duties may be summed up as follows:

1. Introduction of the right type of people into an organization.
2. Proper placing of such people.
3. Advancement of deserving people when opportunities present themselves.
4. Infusion of the right spirit among workers so that they may be justly proud of their organization.

To have a body of workers assured of their future, results in loyal and contented people and should mean a great deal to any concern. Floaters would automatically be taboo.

As an illustration of what I have in mind, every job or position in an organization should have a definite value. Let us take Department T, in which there are four men and one girl. The jobs in that department could then be classified in the following manner:

1. $200 to $250 per month
2. $150 to $180 " "
3. $90 to $120 " "
4. $60 to $80 " "
5. $60 to $125 " "

If every position were thus classified, it would simplify the work of providing advancement for people all over the organization. If a job were rated at $150 to $180 per month, the annual increment being $10, it should be the duty of the personnel department to make sure that a man's work has merited an increase which should be granted without any begging for it. I don't know how other people feel about having to beg for a raise, but I have always abominated it. It seems so undignified that it should be eliminated. Every job has a rated maximum value, and if a man is drawing his maximum, his further advancement will depend upon other openings in the organization, which would be a matter for the personnel department to look after. It should hardly ever be necessary to go outside the organization for men to fill positions if the personnel department is functioning correctly.

The department should keep an accurate record of every man's career, classifying his education, experience, salary, and every other matter that needs to be recorded. This might be a tedious job at the start, but once compiled it would be easy to keep the data up to date.

There should also be a separate classification of qualifications and experience. For example Mr. A may have good records as a pump sales engineer, as a foreign sales representative, and as an electrical engineer. Each

such qualification would form a separate classification, and under each one would be several names, so that when the personnel department had a call for a man with definite experience it would have no difficulty in making suitable suggestions.

By this means every man in the organization is classified. His salary increments are automatically cared for. His advancements to better positions are not hit or miss. And in the long run the organization gains in efficiency. The men who go on advancing are familiar with the general policies of the company they work for and are too jealous of their positions to be found guilty of anything that would disgrace them or bring discredit to their employers.

All matters relating to the careers of men or women should always go through the personnel department, and my thought is that such a department should be subordinate only to the president of the organization. A committee appointed by the president and composed of five or six responsible men, the personnel department manager being one ex officio, would be a useful and perhaps necessary asset. It would dispose of establishment matters coming up from the personnel department, and would, I believe, prevent glaring cases of miscarriage of justice.

We often come across men who are dubbed as ill-tempered, lacking in tact, insufficiently guarded in speech, and so forth. Rather than let a man continue with these defects he should be told about them and an effort made to help him to correct these faults. An organization lays careful plans for caring for machinery. Is the human element in the organization less important than the machines?

Ordinarily all complaints or grievances should be easily disposed of by a department manager, but there are occasions when an employee will feel dissatisfied with a decision. He should then be permitted the privilege of taking the matter further through the personnel department. Personally, I abominate verbal complaints. People can say anything, will often exaggerate grossly, in an effort to cause trouble. This practice should obviously be discouraged. If a person has a serious complaint, he should be made to reduce it to writing. It will generally be found that when this is insisted upon it will act as a deterrent. I have come across so much of this tittle-tattle stuff with which private secretaries, stenographers, and privilege-seeking rats take a delight in poisoning the minds of executives, that I wonder why big men stand for it. A proper personnel department, functioning independently, would stop all such nonsense, and a foolish executive might soon find himself on the carpet for his follies.

In the same manner that an organization expects the highest type of integrity from its employees it should observe the Golden Rule in its dealings with employees.

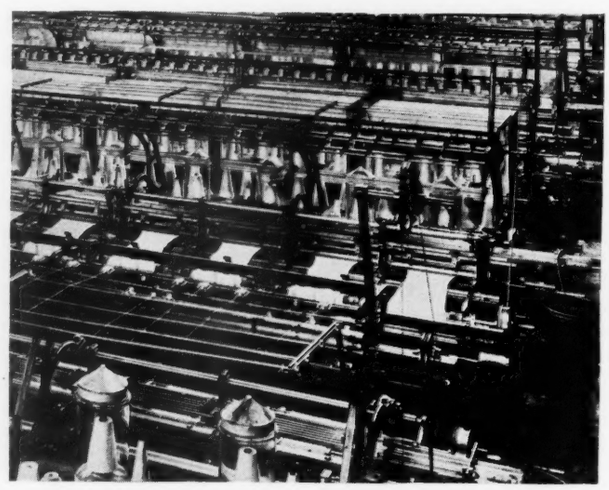
During this depression good men have been hard put to it to get any kind of work, and some employers have taken deliberate advantage of the situation. I know of a man employed on a monthly salary who was called into the office one Saturday and without even a day's notice was handed a check up to that time and let out. The company had definite rules regarding vacations—one day for each month of service—and in spite of a protest this employee received nothing for the vacation that was due, and it took several weeks of letter writing before he received two weeks' pay in lieu of notice.

This was distinctly dishonest, and it is hoped that when President Roosevelt makes the new law operative there will be some court of appeal to which distressed men can go.

We are on the eve of radical changes in our industrial life, and the President's utterances should mean much to both employers and workers. The Recovery Act requires that certain provisions shall be included in every basic code submitted to Washington. One of these provisions is that employees shall have the right to organize and bargain collectively through representatives of their own choosing and shall be free from the interference, restraint, or coercion of employers of labor or their agents. The surprising part of it is that no one has been sufficiently interested in the workers' problems to have considered this necessary a long time ago.

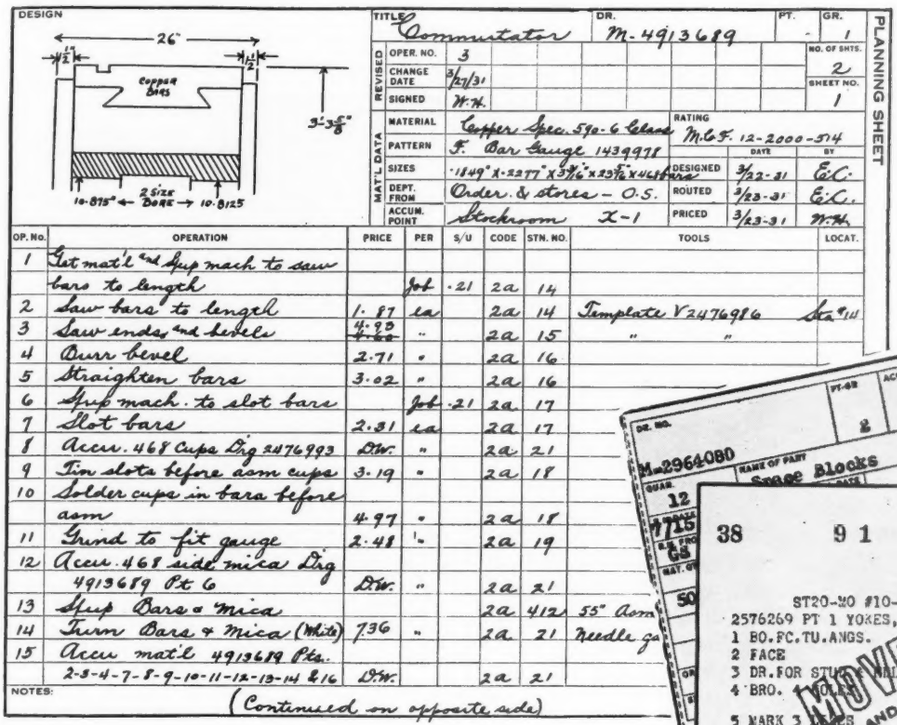
A large number of today's workers are holding depression jobs, and full advantage has been taken by some employers of the misfortunes of these people. When President Roosevelt said "there is no group in America that can withstand the force of an aroused public opinion," he gave us much to think about.

A proper personnel department should be the aim of every responsible organization, and a committee of workers' representatives should be a welcome link between employers and employees. There are lots of intelligent workers whose opinions would be of great value to employers, and the President's appeal at a time like this should make it simple to start now. The day for business despots is fast approaching an end. If conditions are right in an organization, workers cannot help being loyal and faithful, and I can conceive of nothing surer to get results than a real spirit of cooperation between workers and employers.



Why do successful concerns take the best care of machinery but neglect their personnel? A man in overalls wants to know

▼ ▼ ▼



DESIGN

26"

Copper Bars

3"-3⅝"

10.875" ← 2 Size Bore → 10.8125

TITLE Commutator DR. M-4913689 PT. - GR. 1

REVISED: OPER. NO. 3 — CHANGE DATE 3/27/31 — SIGNED W.H. — NO. OF SHTS. 2 — SHEET NO. 1

MAT'L DATA: MATERIAL Copper Spec. 590-C Class — PATTERN F. Bar Gauge 1439978 — SIZES .1849" x .2271" x 3⅞" x 23⅝" x 46⅛ bars — DEPT. FROM Order & stores - O.S. — ACCUM. POINT Stockroom X-1

RATING M.C.F. 12-2000-514

	DATE	BY
DESIGNED	3/22-31	E.C.
ROUTED	3/23-31	E.C.
PRICED	3/23-31	W.H.

PLANNING SHEET

OP. No.	OPERATION	PRICE	PER	S/U	CODE	STN. NO.	TOOLS	LOCAT.
1	Get mat'l and ship mach to saw bars to length		Job	.21	2a	14		
2	Saw bars to length	1.87	ea		2a	14	Template V2476986	Sta 11
3	Saw ends and bevels	4.92 1.60	"		2a	15	" "	
4	Burr bevel	2.71	"		2a	16		
5	Straighten bars	3.02	"		2a	16		
6	Ship mach. to slot bars		Job	.21	2a	17		
7	Slot bars	2.31	ea		2a	17		
8	Accu. 468 Cups Dig 2476993	Dw.	"		2a	21		
9	Tin slots before assm cups	3.19	"		2a	18		
10	Solder cups in bars before assm	4.97	"		2a	18		
11	Grind to fit gauge	2.48	"		2a	19		
12	Accu. 468 side mica Dig 4913689 Pt 6	Dw.	"		2a	21		
13	Ship Bars & Mica				2a	412	55° Assm	
14	Turn Bars & Mica (Mica)	7.36	"		2a	21	Needle ga	
15	Accu mat'l 4913689 Pts. 2-3-4-7-8-9-10-11-12-13-14 & 16	Dw.			2a	21		

NOTES: (Continued on opposite side)

Figure 1. When paper is hectographed, a copy of the planning card serves as a tool-crib record. The tool-crib copy used in plants that prepare paper mechanically was reproduced in the May issue (see page 197, Figure 5)

Figure 2. Tool-check copies of the individual order, whether hectographed or prepared mechanically, serve the tool-crib attendant as a notice to accumulate tools

DR. NO. M-2964080 — PT-GR 2 — ACCUM. STN. 101 — SHOP ORDER NO. 450782 — DATE 7/15 — ORDER BY ZK — REQ. NO. RK 718 M — S.N. NO. M 58407 — DELIV. TO — TOOLS O.K. — DATE DELIVERED 7/13 — NAME OF PART Gauge Blocks — QUAN. 12 — B.B. PRC 7715 — B.B. DEL'D GS — SAT. O.K. — GR 50

38 91 95 97 151234

ST20-MO #10-ST26
2576269 PT 1 YOKES, C[illegible] PATT-C

1	BO.FC.TU.ANGS.	[illegible]	[illegible]		3.5E
2	FACE	40[illegible]	[illegible]		1.40E
3	DR.FOR STUD	MILL 32Q MO	15.		1.56E
4	BRO. 4 YOKES	[illegible] MO	15.		1.10E
5	MARK 3 [illegible]	439 MO			72.C
6	SNAG BEFORE F&J OP	428 MO		FIX 628789	45.C
7	C-SINK FOR RV.	420 MO	10.		22.5C
8	STAMP 2 ARROWS	439 MO			40.3C
9	STAMP A1 & A2	438 MO			56.C

MOVE CARD WITH TOOL OBJECT

Production Control

8. *Tools*

Thomas M. Landy

TOOL CRIBS, like many of the other service organizations, are often neglected and poorly managed sections because of a wrong attitude on the part of the management. Frequently the man in charge of a tool crib is a good mechanic but not a good supervisor.

Perhaps none of the so-called service sections is more important than the tool crib. The very life of a manufacturing department may be said to depend on the proper flow of tools.

Many executives talk material inventory reduction from morning until night when, with half the energy, they could reduce their tool inventories and secure far greater monetary return. In some of the older, larger plants thousands of dollars' worth of small tools are left in the hands of the various operators. I remember a case in a large shop where, when an operator retired, three wheelbarrows of small tools were removed from his cabinets. They represented an investment to the company of thousands of dollars. An important question is how far to go in issuing tools to an operator to hold permanently in his possession. There are cases where it is good business to issue tools for permanent possession, as with layout men, but certainly it is not good business to issue $5000 worth of tools to every operator in a shop employing 800 men. Yet there are such cases. Obviously, it is more economical to set up a central tool crib and cut tool inventories in halves or even thirds.

Often a job may be held up, waiting for a tool, when the very tool necessary to do the job is in an operator's cabinet. Then, of course, there is the other evil, that of a poorly operated tool crib. If good records are not kept, tools may be duplicated endlessly, and the tool inventory built up all out of proportion. The solution seems to be a well-planned crib (in very large plants tied in with a central tool section) supervised by a man who is an executive as well as a mechanic.

With these two rules as a basis, a good tool control should be installed and operated. There are many systems in use, but the following is perhaps as simple and effective as any.

When the planning card is set up, in those plants using the hectograph method of paper preparation, carbon copies are issued to the tool crib of each manufacturing section involved (Figure 1). In those plants equipped with the mechanical method of paper preparation, a tool-crib copy (See Figure 5, May, page 197) is run off at the time the dupligraph plate is set up.

The two last columns on the planning card are re-

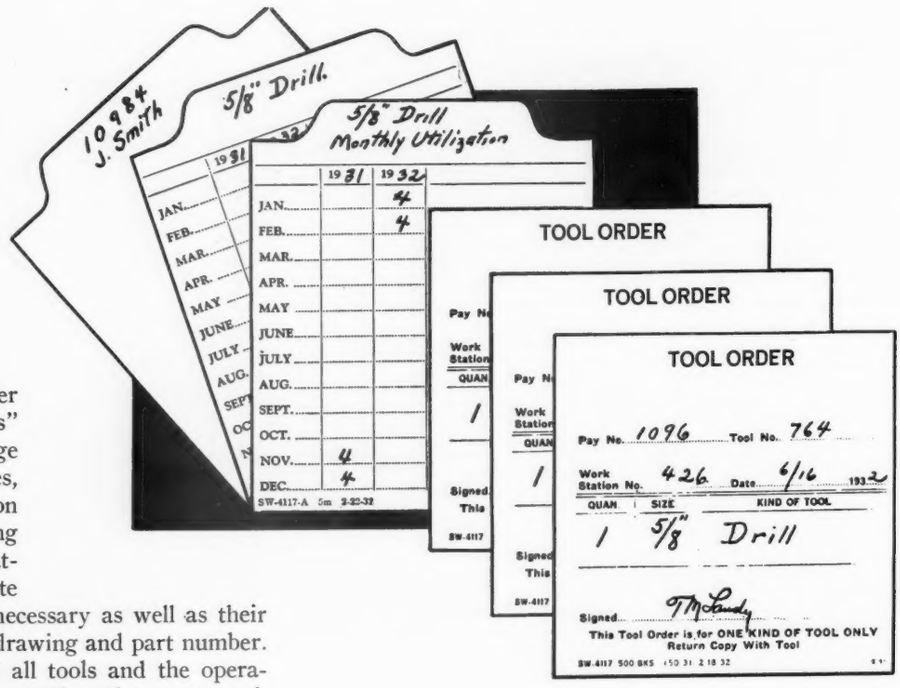


Figure 3. Illustrating the small-tool order prepared in triplicate and filed against the name and number of both operator and tool. When the tool is returned, the operator receives the original, and the duplicate is filed for periodic analysis in the utilization file

served for tools. The planner assigns under the caption "tools" the drawing number of any large tools, dies, jigs, fixtures, plates, colletts, chucks, etc. Then upon receipt of a copy of the planning card or tool-crib record the attendant enters upon it opposite each operation all small tools necessary as well as their location by bins, and files it by drawing and part number. He now has a complete file of all tools and the operations on which they are used, as well as the exact work station where the work is performed.

When the tool-check copy (Figure 2) of the individual order is received on a current order, the attendant has merely to look at this card to accumulate all tools necessary for the job.

The tool-check copy is filed by tool accumulation date. When this date comes due, the attendant removes the card from the file, checks the master tool file (copy of planning card or tool crib record), accumulates all tools necessary.

The tool crib supervisor then turns the tool check over to the dead-load file clerk. When the material has been delivered to the proper work station, this tool check is returned to the tool crib where it acts as a notice to deliver the necessary tools.

It is obvious that every time the master planning card in the planning section is changed in any way a corresponding change must be made on all tool-crib copies. In factories using the mechanical method of making paper, all that is necessary when the dupligraph plate is changed is to run off the proper number of new copies of the tool-crib record for the various cribs involved.

The above routine takes care of all data necessary to operate the tool crib, except in the matter of small tools such as drills, taps, reamers, cutting tools, etc. To take care of this latter class, the following simple system is recommended (see Figure 3).

Each time an operator comes to the crib for small tools he makes out a tool request form in triplicate. He keeps the triplicate and turns the original and duplicate over to the crib attendant.

The original is filed in a suitable file against the operator's name and number. The duplicate is filed in the tool file against the name and number of the tool. Thus we have a cross reference showing at all times what tools are in the possession of each operator.

When the operator returns the tools, he turns back his triplicate copy and is handed the original copy which he destroys. The crib attendant then removes the duplicate from the tool file and destroys the triplicate. The duplicates are then filed in the tool utilization file where they may be analyzed periodically.

[Mr. Landy's ninth article—on the foreman's responsibilities in production planning and control—is scheduled for November publication.—ED.]

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British Industry Acclaims Compulsory Health Insurance

WHEN David Lloyd George sponsored Great Britain's National Health Insurance Act in 1912, the measure met with bitter opposition from all sections of society. Today, writes Arthur W. Allen, Foreign Editorial Correspondent of McGraw-Hill Publications, compulsory health insurance in Great Britain is acclaimed as an important contribution to the overthrow of forces that looked to social revolution as a means of relief from the physical uncertainties and financial hazards which beset the lives of the industrial workers in capitalistic countries.

The measure involves the keeping of cards to which employer and employee affix stamps representing regular contributions to a government supported fund that provides for medical care and facilities. Today the Act safeguards the health of about 16,000,000 people. The patient may choose his own medical adviser, thus overcoming one of the serious objections raised to the usual compulsory insurance plan.

Twelve countries have followed Great Britain's lead. The British plan is financially as well as socially successful; the fund shows a large surplus of receipts over expenditures.

66,000 Man-Hours in This Little Capital-Goods Order

Enlightening figures at any time, but especially so in these days of putting people back to work

WE ARE indebted to E. J. Patton, of the Stephens-Adamson Manufacturing Company, of Aurora, Ill., for these figures on hours of labor involved in the manufacture of the mail-handling conveyors that his company is supplying for the Atlanta, Ga., post office. Mr. Patton's statement follows:

This particular post office is not a large project, and the mail-handling system is but one of the subcontracts let by the Great Lakes Construction Company of Chicago; yet it will mean a total of considerably over 66,000 hours of skilled labor, punched on time clocks in more than 20 states.

In Aurora, 150 men were kept busy for over three weeks—engineers, draftsmen, pattern makers, machinists, fitters, painters, and clerical help, whose time totaled 22,500 hours.

In Chicago, the Shafer Bearing Corporation gave 11,460 hours of work to make the 8,000 bearings and pillow blocks on which the mail will be carried. The W. A. Jones Foundry and Machine Company spent 4,500 man-hours in building the inclosed speed reducers for drives.

In Milwaukee, the Cutler-Hammer Manufacturing Company gave 1,800 hours of skilled labor in building the electrical control equipment, while the drive motors gave workmen at the Louis Allis Company 640 hours. The flexible couplings account for 100 more hours.

Foundry employees in a St. Louis plant got 600 hours. Steel mill employees spent 1,680 hours on the steel plates, angles, and channels used as mail chutes and machinery supports.

Canvas conveyor belts, on which the letters, packages, and bags are carried, totaled 14,740 man-hours for Philadelphia workmen in the Main Belting Company's plant. This one item of equipment yields some interesting figures and indicates the nation-wide distribution of labor which cannot even be estimated. The 9,734 feet of 36-in., 4-ply and 42-in., 5-ply belting required 32,985 lb. of cotton duck, 3,298 lb. of cotton twine, 87 500-lb. bales of cotton, 1,755 gal. (33.7 bbl.) of oil for treating, 700 gal. (13 bbl.) of paint, and 2,000,000 lineal feet of stitching. The duck used would cover 139,552 sq.ft., or 3.2 acres, and 335 people were given employment.

The foregoing totals do not include such items as grease for conveyors, bolts and rivets, steel tubing and shafting for conveyor rollers, wear and tear on machinery, power required, or the very large item of freight and handling. The benefit to the railroads and trucking companies can only be imagined when you take such totals as two carloads of belting, a carload of steel tubing, a car of speed reducers, a car of shafting, six cars of steel, and numerous other items, most of which had to be consolidated at Aurora for fabrication and a final shipment of eleven carloads to Atlanta, over 700 miles away.

At Atlanta, the conveyors must be erected, wired for power, tested, and painted—a task that is estimated to take 7,220 more hours of skilled labor.

Here are the nation-wide benefits from this one subcontract: (1) Atlanta will be able to handle mail quickly, cheaply, and with practically no damage or breakage; (2) over a thousand men will have been employed *at the jobs for which they are best fitted;* (3) the labor has been spread over more than 20 states.

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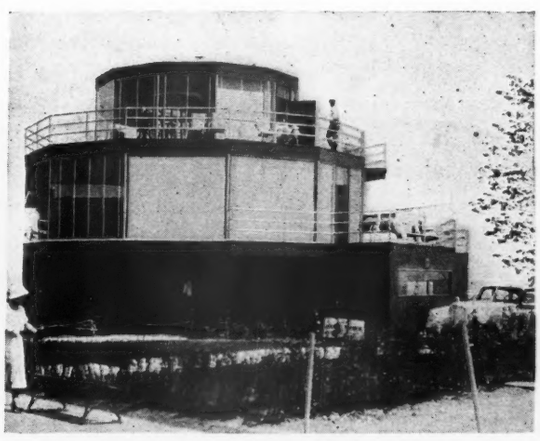

Tomorrow's House

Many changes in markets will result when, as, and if this "House of Tomorrow" comes into general use. Steel frame, glass walls, utilities including garage and hangar on the first floor, living rooms on second, and sun room on top

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

SEPTEMBER, 1933

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NRA Gathers Speed

AUGUST, 1933, goes down on the record as an extremely important month in industrial history. Ordinarily given over to marking time, this year it has witnessed activities of lasting import, thanks to the Recovery Act.

A basic industry (lumber) was given a price control arrangement and an allocation plan. Base prices in another basic industry (oil) can be fixed by the President himself.

The principle of the "code authority" became well established, notable examples being in the steel and lumber industries.

Industry's obligations to labor and the extent of labor's control of industry were faced. Concerning the labor provisions of the NIRA, the Administrator made a clarifying statement that may become an important historical document. A statement supplemental to paragraph 7 (a) of the Act was permitted in the automotive code. The National Labor Board, designed to prevent strikes and labor troubles, by eliminating the causes, has swung into action with commendable accomplishments.

The steel industry took advantage of suspension of the anti-trust laws, and prescribed procedure on prices, terms, discounts, sales agreements, and penalties for violations.

In the past all of these matters have contributed to the operation of industry on a basis of confusion and conflict. Recently they have prevented the speed desirable in getting into operation under the NIRA. Their removal, or at worst their partial clarification, brings much nearer the end of the preparation proceedings necessary before the NIRA can be put into effect on a scale large enough to provide a real test.

With so much progress made in one month the outlook for success of the plan for a new order in industry improves. Industry is giving much evidence of its necessary confidence, cooperation, and ability to govern.

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Labor's Responsibility

BY THE terms of the National Industrial Recovery Act labor has obtained a saddle seat firmer than any it has ever had. With this greater advantage it must not ride too hard for fear of killing the steed. If labor attempts to establish a union monopoly, a dictatorial rather than a cooperative régime, it faces the same obstacles that must be overcome in building any other monopoly.

It was said recently that paragraph 7 (a) of the Recovery Act (the labor paragraph) is the darkest cloud on the industrial horizon; that it endangers the success of the whole Roosevelt program. No stretching of the imagination is required to conclude that labor organizations must play the game or they will lose out, with much misery for the whole country during the process.

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NRA Labor Statement

THE PLAIN meaning of Section 7 (a) cannot be changed by any interpretation by any one. It is the function of the administrator and the courts to apply and to interpret the law in its administration; and no one else can assume this function, and no official interpretation can be circumscribed, affected or foreclosed by any one writing his own interpretation into any code or agreement. Such an interpretation has no place there and cannot be permitted.

The words "open shop" and "closed shop" are not used in the law and cannot be written into the law.

These words have no agreed meaning and will be erased from the dictionary of the NRA.

The law requires in codes and agreements that "employees shall have the right to organize and bargain collectively through representatives of their own choosing."

This can mean only one thing, which is that employees can choose any one they desire to represent them, or they can choose to represent themselves. Employers likewise can make collective bargains with organized employees, or individual agreements with those who choose to act individually; provided, of course, that no such collective or individual agreement is in violation of any State or Federal law.

But neither employers nor employees are required, by law, to agree to any particular contract, whether proposed as an individual or collective agreement.

The law provides that employees shall be free from interference, restraint or coercion of employers in the exercise of their rights established by the law. The conduct of employers which is here prohibited has been defined by the Supreme Court in the case entitled T. & N. O. R.R. v. Brotherhood of Railway Clerks, 281 U. S. 548. The rulings of the Supreme Court lay down the law which governs the NRA.

Under Section 7 (a) employers are forbidden to require "as a condition of employment" that an employee shall either "join a company union" or "refrain from joining, organizing, or assisting a labor organization of his own choosing." The law does not prohibit the existence of a local labor organization, which may be called a company union and is composed only of the employees of the company. But it does prohibit an employer from requiring, as a condition of employment, that any employee join a company union and it prohibits the maintenance of a company union, or any other labor organization, by the interference, restraint or coercion of an employer.

If there is any dispute in a particular case over who are the representatives of the employees of their own choosing, the NRA will offer its services to conduct an impartial investigation and, if necessary, a secret ballot to settle the question.

The NRA will not undertake in any instance to decide that a particular contract should be made, or should not be made between lawful representatives of employees and employers; or to decide that a contract which has been lawfully made should not be enforced.

Cooperation in all industrial relations depends largely on the making and maintenance of agreements. The NRA will promote and aid such cooperation.

HUGH S. JOHNSON
DONALD R. RICHBERG

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Code Authority

ALTHOUGH not prescribed in the Recovery Act, the principle of "code authority" has become well established as an agent of enforcement. Precedent is found in the lumber and steel codes. Lumber sets up a "Lumber Code Authority, Incorporated," to "issue and enforce such rules, regulations, and interpretations, and impose upon persons subject to the jurisdiction of this Code such restrictions as may be necessary to effectuate the purposes and enforce the provisions of this Code." Its membership includes representatives of the principal divisions of the lumber industries, plus three non-voting members "to be appointed by and to act as advisory representatives of the President."

Steel's administrative authority is vested in the board of directors of the American Iron and Steel Institute, plus the Administrator for Industrial Recovery and one or two persons appointed by him.

Where the Worker Stands

MUST an employee join a labor union to get a job or hold one? The Administration settles that question, checkmates any and all misleading propaganda, by permitting the automobile manufacturers to clarify the labor clause in the Recovery Act. Section 7 of the automobile code, approved August 27, contains this supplementary statement:

"Without in any way attempting to qualify or modify by interpretation the foregoing requirements of the national recovery act, employers in this industry may exercise their right to select, retain, or advance employees on the basis of individual merit, without regard to their membership or non-membership in any organization."

A similar clause appears in the newspaper publishers' code. It reads:

"The right of employer and employee to bargain together free from interference by any third party shall not be affected by this code, and nothing herein shall require any employee to join any organization or to refrain from joining any organization in order to secure or retain employment."

•

Price Fixing and Allotment

LUMBER and oil set the pace when it comes to showing how far control of production and prices may be written into a code. The lumber code, which incidentally has everything an undertaking in industrial self-government should have, provides for control of production by allocating quotas based on estimates of expected consumption of lumber and timber products of each species, and taking into account average hourly production, greatest yearly production, greatest average number of employees for any three calendar years since 1924, proportion of taxes paid to total paid in the division, and proportion of reserve standing timber (owned or controlled) to total for the division.

The cost "protection" clause empowers the code authority to establish and from time to time revise prices designed to protect the cost of production in the several classifications of lumber and timber products; provides that such minimum prices shall be established with due regard to the maintenance of free competition among species, divisions, and subdivisions, and with the products of other industries.

The oil industry, on the other hand, relies on regulation from above. The President himself will prescribe base prices, set production quotas, when, as, and if he sees fit to do so.

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There Lies Prosperity

EVIDENCE of economic enlightenment was piling up even before the NIRA came on the scene. It lay in the gratifying number of announcements of salary and wage increases. In-

creases, if not enlightenment, have been greatly accelerated by the application of the Act.

That restorations were made so early in the business upswing is indicative of a broad understanding that purchasing power must be placed in the hands of the many if industry's products are to be bought.

Wants of people are inexhaustible. People will spend to fill those wants if they are assured of income. We need not fear overproduction if we can but provide a distribution that will match purchasing power and wants.

•

Industry Takes Charge of Its Standards

INDUSTRY has been given another opportunity to work out its own problems, through the announcement that some of the simplification and industrial standardization activities heretofore carried on by the Bureau of Standards have been discontinued, as an economy measure. Responsibility for continuation of the work has been accepted by the American Standards Association.

The Bureau pioneered the highly important work of standardizing and simplifying a wide variety of products, with resultant savings of hundreds of millions of dollars to industry and consumers. It is likely that the Bureau was in better position than any other organization to initiate such a movement. Now that the procedure has been established and the value of the work amply demonstrated, relinquishment of further responsibility to a single organization that is representative of industry, the public, and the government, is likely to be beneficial.

A federation of 37 national technical societies, trade associations, and government bodies, the American Standards Association was organized in 1918 to serve as a clearing house through which the standardization work of technical and industrial groups could be correlated. Its work is carried on by 400 standardization committees, with some 3,000 technical experts.

Under the new arrangement the Bureau will cooperate in carrying on at least part of the research and laboratory work necessary in connection with standardization projects, but industry will rightfully assume the work and the cost of shaping its own standards. This is an important step in the right direction.

Getting Ready to Take On Help

AFTER being on the shelf for years, employment is fast becoming a live issue again. Firms can no longer count on calling back employees long ago laid off. It is safe only to count on breaking in a green force.

One large company recently paid bonuses, running up to 25 per cent, to a selected 10 per cent of its employees. These bonuses were for assisting in the supervision of small groups of employees, and for cooperating with foremen and management in a special training intended to prepare these employees to act as leaders and helpers in breaking in the new employees soon expected to be required. Selection of the group is 50 per cent on the basis of leadership ability, the balance on the basis of quality and output, loyalty, and experience and education.

Companies which have left the problems of re-employment to take care of themselves are likely soon to find themselves in a serious jam.

•

Need Engineers?

FOR a laudable plan just being put into operation, we bespeak the cooperation of employers. It has to do with putting engineers back to work.

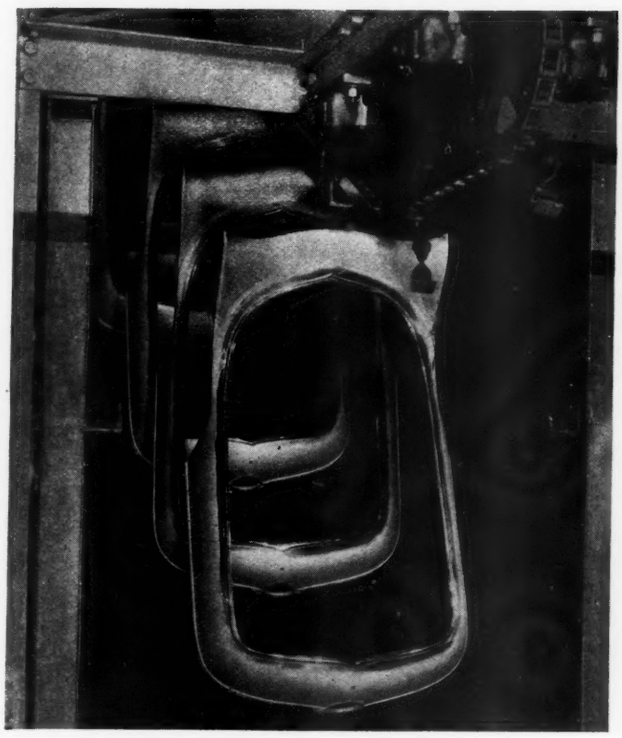
Here is the plan, formulated by The Professional Engineers' Committee on Unemployment: Within each industry a committee will study that industry to discover opportunities for engineering usefulness. The P.E.C.U. will notify properly qualified engineers that the opportunities are available. These engineers must secure positions through their own efforts.

It is the attitude of the Committee that the positions opened up must not interfere with anyone now employed; must bring an attractive financial return to the employer; must be positions that only the engineer can fill.

In endorsing this plan, let us point out that prior to the depression engineers enjoyed a demand for their services, with the consequence that they are unpracticed in job-making. Hence they need the help that they are getting from the Committee on Unemployment. Obviously, the Committee needs the help of employers. Actually, employers need the financial return that they can get from the employment of engineers either as increase in net earnings or as prevention of waste.

SHORTS FOR MANAGEMENT FOR MAINTENANCE

"Induction-Heat" Oven



SOURCE: Plymouth Motor Corporation, Detroit

Radiator shells are finished in an oven that bakes enamel more efficiently with less heat and greater cleanliness. In this baking process, the radiator shell moves through a series of electrically charged wire coils. The secondary current passes through the shell, bakes on the enamel at even temperature. Shells are actually hotter than the oven

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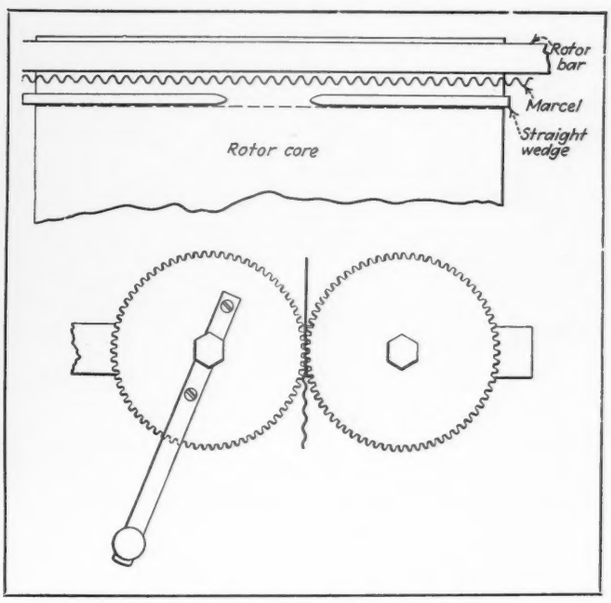
Permanent Repair of Troublesome Rotors

SAMUEL OVANDO, San Francisco, Calif.

Several squirrel cage rotors of like construction on similar drives were constantly giving trouble because of bars breaking their brazed bond at the rings. The rotors were designed for high torque and quick stopping by reversing the field at full speed. Investigation disclosed that the construction allowed a very slight movement of the bars to take place in the slots. This suggested undue vibration at the point of bond on the rings as a possible cause of the trouble. Breakdowns ceased as soon as the bars were tightened in the slots. Procedure in one case will be described in order to illustrate the method.

In this rotor there were 119 copper bars and six alloy end rings. That is, three rings on each end made of $\frac{1}{16}$-in. sheet alloy and punched with close fitting holes for the bars to pass through at the point of contact. The bars were $\frac{1}{8} \times \frac{5}{16}$ in. Mica cells in the slots were intended, perhaps, more for tightening the bars than for insulation. In the original construction maple retaining wedges were driven between the bar and the top of the T slot to tighten the bars. These were driven out in order to provide space for metallic wedges such as those illustrated

Corrugated metallic strips, so shaped to take care of variations in space and still exert pressure, were placed in the slot bottoms. In some cases these were made from



sheet phosphor bronze and in others from strips of mild spring steel. The thickness of these "marcels" was $\frac{1}{32}$ in. Straight wedges, as shown, were cut to length from standard cold rolled stock. They were driven from each side between the marcel and the slot bottom with a light pneumatic hammer.

Incidentally, such positive tightness of bars in the slots as results from this method is not likely to be accomplished without grounding the winding. However, a squirrel cage winding can be impaired but slightly, if at all, by grounds no matter how numerous.

Various processes for forming the marcels may suggest themselves, but the sketch illustrates one method which has proved practicable.

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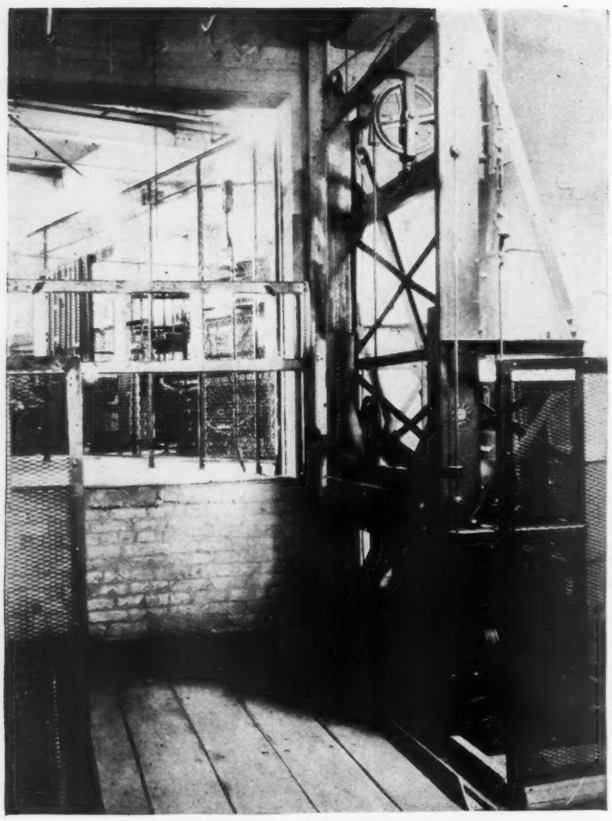
Small Lift Saves Space

A difference in floor level of about three feet between a new and an old building in the plant of the Hygrade Lamp Company made it necessary to decide upon some means of transporting material in small hand trucks between the two buildings.

It finally came to a choice between a ramp and an elec-



trically operated lift. Because it requires considerably less floor space and because less danger and effort are occasioned by its use, the lift shown in the illustration was installed. A push of a button causes it to travel to the required level where it is stopped by a limit switch.

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Photo-cell installation in a Procter & Gamble power plant stops flow of oil when fire accidentally goes out under boiler and prevents explosions.

•

Stack Extended, Ventilation Money Saved

C. C. Hermann, Waterloo, Iowa

A ventilator spinning around at the top of a stack is a common sight. Eddy currents, usually produced by the walls of adjacent buildings, cause this action. I made a check on an installation of this character with the following results:

The rated capacity of the ventilator was 225,000 cu.ft. of air per hour with a wind velocity of four miles per hour. The stack, with diameter of 30 in., extended 10 ft. above the roof of the building. Within 16 ft. of the stack was the brick wall of an adjacent building extending about 40 ft. above the other roof.

An anemometer showed an average stack velocity of 130 ft. per min., giving a volume delivery of 38,220 cu.ft., or 17 per cent of rated capacity. After raising the stack 40 ft., the air velocity in the stack was 570 ft. per min., giving a volume delivery of 167,580 cu.ft. of air per hour, or 74.4 per cent of rated capacity.

A saving of more than $400 was made by increasing the stack height as compared with the purchase and installation of additional ventilators to remove the equivalent volume of fumes.

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"Short" undercoats have been found preferable to paints with high oil content for painting and maintaining outdoor electrical apparatus.

•

Same Load, Less Power

A Southern concern which had a number of plain-bearing lineshafts in its plant asked the power company to check the power input to each of seven motors operating from the shafting; found electric power consumption was 51.34 kw. The shafting was then realigned. Anti-friction bearings were installed. A few months later, the power company again ran tests. With the same line-shaft load and no change in operating procedure except the realignment of the shafting and the shift in bearings, the power consumption was found to be 29.13 kw.

Without figuring in any saving for labor and lubricant, the return on the original investment of $2,000 will pay for the installation in about two years' time

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Steel Case Protects Pushbuttons

A. A. A. Rodrigues, Maintenance Electrician
Candy Headquarters, New York, N. Y.

Pushbutton switches often must be mounted in locations where the projecting buttons are likely to be knocked off or smashed by trucks, other moving equipment, or by careless handling.

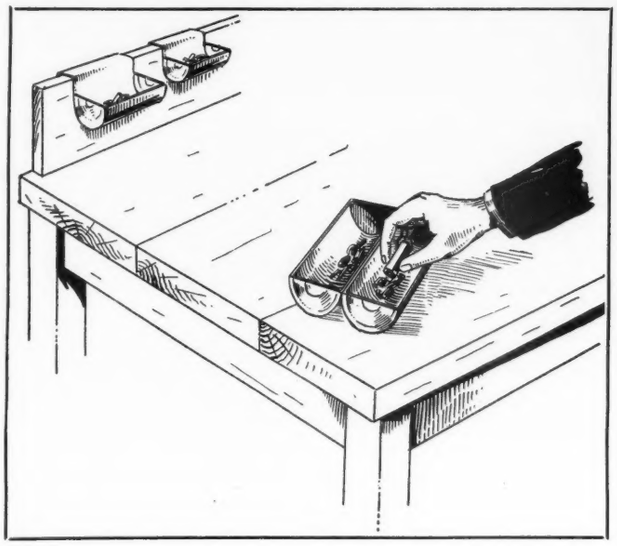
After several instances of smashed or broken buttons in our plant we took steps to protect the buttons. A method used to protect switch boxes containing two or more switches follows: A piece of $\frac{1}{8}$-in. flat steel, long enough to encompass the two sides and bottom of the switch box and wide enough to extend from the back of the box to $\frac{1}{8}$ in. beyond the switch buttons, was screwed to the switch box. The front corners of this protecting armor were rounded off to make a finished job.

The illustration shows the method used to protect single switches against button - smashing. Here the ears of the switch box first were removed and replaced by flush substitutes. Then the switch was mounted in the box of $\frac{1}{8}$-in. steel so that the buttons always were $\frac{1}{8}$ in. inside of the protecting edges.

Small Hardware Containers Made from Tin Cans

CHAS. H. WILLEY, Penacook, N. H.

Don't waste time hunting through a bin full of small nuts, bolts, washers, and what not for the item you need. Make up a number of hardware containers from large round cans as indicated in the sketch. Such containers



are made easily, and they contain no square corners or straight sides to prevent you from scooping out the needed parts with your fingers.

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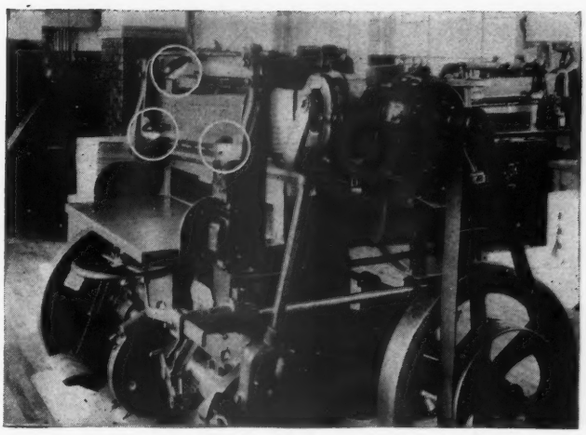
Sounding for Silence

Westinghouse engineers use a trombone-like stethoscope to listen in on minute noises in refrigerator motors. Inside this soundproof room capacitor-type motors of slightly different electrical and mechanical design are compared



Photograph by courtesy of MacNutt, Watts & Tankard, Inc.

Light Where It's Needed Most

Three shaded bulbs, installed directly over the knife of this paper-cutter, give plenty of light without confusing shadows where the operator needs it most, and prevents his fingers being sliced along with the stock he is trimming.

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Aluminum sheets may be electrically annealed with temperature variation of less than plus or minus 5 degrees. Precise control safeguards the quality of the charge.

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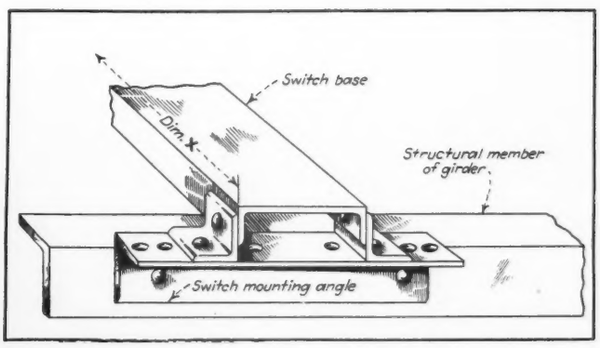

Mounting for Switch Bases On Substation Structure

WALTER B. MORTON, Philadelphia Electric Company
Philadelphia, Pa.

In designing substation structures of the box girder type the problem of providing a suitable mounting for the bases of switches, fuses, and other equipment frequently arises. Usually, the steel is one of the first items ordered, and must be designed before the base details are known. Unless last-minute changes can be made on the drawings the fitting of the bases must be left to the field.

Use of a uniform mounting suitable for the different types of bases avoids these difficulties and is convenient when equipment is transferred from one position to another. A simple, inexpensive mounting arrangement

consists of a short length of angle bolted to the girder member at each end of the switch position. As shown in the sketch, this angle projects above the girder face sufficiently to clear all projecting bolts and braces, and provides a surface upon which any type of base may be placed. A 6x4-in. angle 15 in. long has been found to be adequate for all ordinary conditions to which this type of construction is applied.

The switch-mounting angle may be shop-punched for the switch base bolt holes, which are laid out for almost any combination required by the various types of switches. In ordering the switches the only information needed by the switch manufacturer is the length of base and distance between gage lines of the mounting angles.

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Safeguards Coal Pile

You court trouble when you pile bituminous coal high and don't take the precaution to level it off and pack it down. Reason, air pockets in which volatile matter is confined and can't expand or escape. Result, spontaneous combustion and serious fire losses. To overcome this hazard a tractor is used with great success to level and pack coal piles at the Huntley Steam Station of the Niagara-Hudson Power Company, Tonawanda, N. Y. It does the job in quick order—a job that used to take a dozen men several days.

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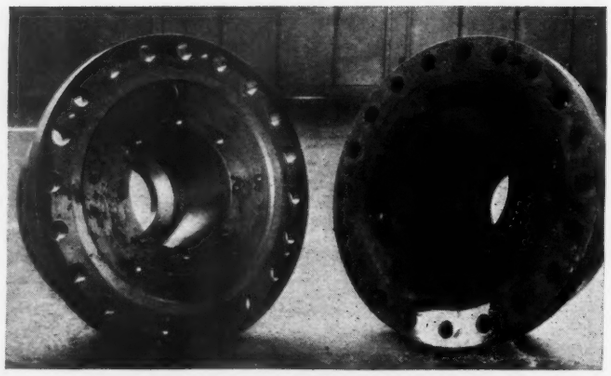
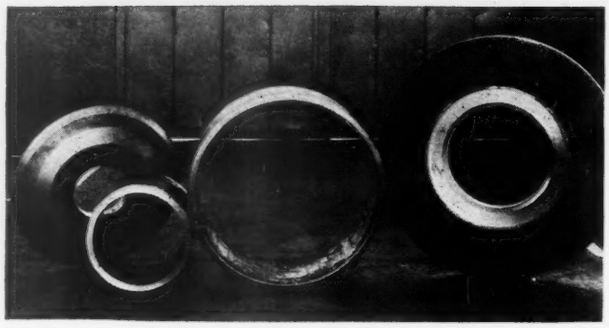
Welded Steel Cylinder Head Saved 25 Per Cent

SOURCE, The Lincoln Electric Company, Cleveland, Ohio

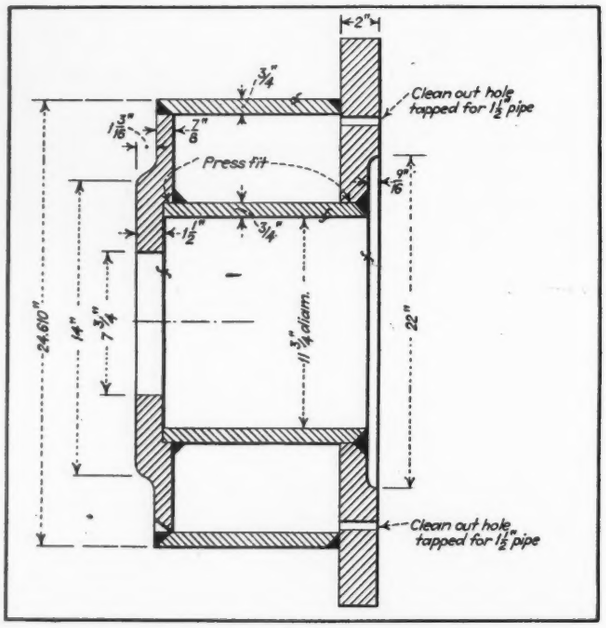
Construction of a steel cylinder head by electric arc welding recently saved 25 per cent of the cost of a new casting for the Ohio Fuel Gas Company, Mt. Vernon, Ohio. The cylinder head is used on a 20-year-old, 1,000-hp. Bessemer gasoline engine. Rapid cooling of the head caused it to crack.

The machined casting shown at the right in the illustration weighs 895 lb.; the corresponding welded steel head at the left weighs 674 lb. The parts composing the





head are shown in the lower view. They consisted of one large plate, 31½ in. outside diameter by 13 in. inside diameter, 2 in. thick; one small plate 23⅜ in. O.D. by 7½ in. I.D. by 2 in.; one large ring made from ⅞-in. steel,



24⅞ in. O.D. by 23⅛ in. I.D. by 11 in.; and one ⅞-in. steel ring 13¼ in. O.D. by 11½-in. I.D. by 12 in.

How the parts were assembled, with the location and types of welds, is shown in the diagram.

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An electronic flasher, without a single moving part and with no contacts to arc, is able to handle huge electric signs.

· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

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What of Cost-Cutting Equipment Under the NIRA?

George Shipman, a works manager, and Frank Fulleger, a plant engineer, are driving to a show—not a theatre, but an exhibition of a line of machine tools, staged by a manufacturer's sales representative. We tune in as Frank is speaking.

* * *

"I'm going to enjoy this, George. And I take my hat off to Bill Fergus."

"What do you mean, you take your hat off? Just a commonsense job he's doing, isn't it, showing his equipment to prospects?"

"I mean that, in the face of all the agitation about putting people back to work, Bill's got his nerve to show these labor-saving machines with the idea of selling them."

"Oh! But not so fast, Frank, not so fast. You don't mean to suggest that we shouldn't install more efficient equipment in order to cut our manufacturing costs?"

"No, *I* don't mean to suggest it. But seems to me it has been suggested by people a lot bigger than I am. I've even read it in proposed codes; at any rate that's been my interpretation."

"But Frank, if you carry that line of thought to the extreme, you'd better dig out those 1924 millers you've got in the warehouse, and use them instead of the 1929 bunch you're using now."

"Oh, I'm way ahead of you, George. You'll step me back to machine-less days in a minute or so, if I let you keep going. And you're right. As I said, it's not my idea. Nevertheless, a lot of people have the feeling that they should get along on what they have for a while, in order to keep as many people as possible at work. And that brings me back to repeat that Bill has his nerve."

"Forgetting Bill for the moment—according to the theory of the equipment-buying-moratorium people, *how long* would they refrain? What's going to happen to the fellow with obsolete equipment? How are costs going to be held down to make sales possible? How about the discrimination against employment in the capital goods industry that such a theory implies? How about the interests of the general buying public? If a moratorium on equipment, why not one on good management, and good maintenance?"

"Don't ask *me*, George. I told you before, those aren't *my* ideas. You've got to stop those infernal questions anyway, because here is Bill's place. Now to look at those cost-cutting machines."

* * *

They go in; maybe they'll buy. Whether they do or not, they've left with us a mass of appealing and important questions, and have suggested others. What are the answers?

What of Cost-Cutting Equipment Under the NIRA?

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ANSWERS TO PREVIOUS QUESTIONS

More or Fewer Records?

(Question presented in the August issue)

NO MANAGER or owner of a business would hesitate to check up on the actual returns brought in by the work of an efficiency expert, the dividends resulting from a newer and more modern method of production, the increase in profit caused by new processes.

Every record and tabulation should be checked to see what use is being made of it; every fact should be examined to see whether the cash receipts of the applications of that fact justify the continued recording.

The trouble with business men in general is not that they keep too many records—they keep too many useless records. If they put every one of their records to a real

use, they are justified in maintaining them. But records for the sake of records are no longer the vogue. The practical and pragmatic business man is tending to keep plenty of records—useful ones.

A record kept by a firm ought to have the same status as any integral part of the firm's work. It should be examined and checked—and if it is weighed in the balance and found wanting . . .

FRED BENNETT, *Superintendent*
Standard Products Company
Cleveland, Ohio

WHETHER we should have more or fewer records depends entirely upon the status of the individual plant or corporation. Practicing Industrial Engineers always find either one of two conditions in any corporation they investigate—under-or over-systematization. Only in a rare case is there just the proper amount.

No set quantity that is universally applicable can be established. After all, this depends solely upon the industry and the type and variety of products manufactured. Frequently we can establish ratios of the clerical labor to direct labor. These will vary widely. For example, in heavy chemical industries this ratio may reach as high as 50 per cent to 75 per cent, while in other lines, such as small metal or woodworking plants, it may drop to as low as 8 per cent to 10 per cent. Seldom does it decrease to 5 per cent or lower. If it does, it generally means trouble for that company or plant.

The tendency to over-systematize is found most frequently with large corporations. Each different function adds just a little bit here and a little bit there, so that records or files may be complete. Many times this results in duplication, which is one of the first things the outside Industrial Engineer looks for.

Frequently large corporations retain systems that were satisfactory for them when they were small, but which have become cumbersome or unwieldy with growth. For example, hand posting of sales or production in ledgers is perfectly satisfactory when a plant has not more than several hundred employees, but when thousands are on the payroll, modern tabulating equipment is necessary. Again, when only a few items are manufactured it is justifiable to have a job-cost system, but when there is wide variety, job costs should be supplanted with operational costs.

In numerous surveys made of bankruptcies in small businesses, it has always been found that failure was due primarily to lack of sufficient cost information. In most cases the small firm maintains only "Accounts Receivable" and "Accounts Payable" ledgers, a Journal, and a payroll record. The costs are usually kept in the owner's head. This spells doom for any business.

Now let us look at the various systems which can be grouped under the heading of "Controls." In cases where none has existed previously, depression or no depression, every corporation, large or small, should have them in some form. A complete system to control labor is essential and absolutely necessary. This should include not only the details for a satisfactory wage incentive, but also the various other features, such as scheduling, planning, standard costs, and inventory controls. To determine how much can be spend needs only a few simple computations. If a plant is on a day-work basis, the labor costs can be reduced approximately 50 per cent. Scheduling and planning will return around 5 per cent more, and inventory controls, when coupled with scheduling and planning, will return at least 25 per cent of the current investment, priced at the going interest rate.

Corporations or plants which already maintain these controls must think very carefully before they discard them. It may appear that the maximum savings have been derived from them. However, the management must determine how much they would lose annually if the controls were discarded. To see this it is necessary only to reverse the figures in the preceding paragraph. But, since service is one of the primary factors of a sale today, will the discard of scheduling and planning force them to lose a major part of their business?

As to maintenance records, we need look only at the past six years to determine our answer. Up until 1929 we could not keep up with a sound maintenance program, generally, and were doing only emergency repairs combined with new construction. "Preventive Maintenance" was not widely developed during the boom period. During the depression wise management readily took advantage of this method of maintenance operation, and did not reduce these expenses in accordance with sales. Records compiled during this time, showing frequency of breakdowns and quantities of various maintenance materials used, coupled with rates of operation, are invaluable and will more than return their cost by improving service and reducing total maintenance expense.

D. M. HEIDER, *Wage Engineer*
Du Pont Viscoloid Company
Arlington, N. J.

Buy or Make Replacement Parts?

(Question presented in the July issue)

THIS is one question which has absolutely one side to it—and that is "Buy replacement parts." To make correctly even one small part of a machine, other machines and skilled mechanics are necessary. How can a small shop owner expect to make his own parts—and make them of the highest quality as regards efficiency and durability?

As for a large shop owner, the thought should never even occur. A man with a factory full of machines and apparatus does not dare take the risk of having his machine parts home-made. At any time these amateur efforts are likely to give way—causing confusion, loss of time, and perhaps even serious danger and damage.

The complaint of long, overdrawn correspondence, mailing or shipping of incorrect parts, mistakes in records and long waits before delivery is ridiculous. Certainly, the buyer and proprietor should be accustomed to doing business with firms where these do not exist. The proprietor should have men in his own business that can handle fully and capably the records and avoid mistakes in asking for parts. It is certain that any reliable company from which he orders will be most careful to give exacting service and errorless and rapid delivery to its customers.

WILL HERMAN, *Superintendent*
Tanenbaum Oil Company, Cleveland

FOR TRUE economy and lowest cost, items must be considered individually.

When to buy parts

1. When quantities are too small to justify set-up.
2. When special facilities are required for fabrication.
3. When plant work of more importance must be given priority.
4. When servicing on part of manufacturer is a necessity to insure desired results.
5. When parts can be gotten readily from manufacturer's stock, insuring prompt delivery.
6. When there is any question as to patent rights or infringement.

When to make parts

1. When study and analysis show original manufacturer's cost to be excessive or prohibitive. This condition is likely to prevail in times of depression when attempt is made to absorb rapidly mounting overhead.
2. When it is in order to reduce overhead.
3. When peculiarities of parts requirements are better understood by the user.
4. When better service and deliveries can be assured by making in sufficient quantities and then carrying as a stores item. There is one danger here; quantities must be held at a minimum commensurate with production and service requirements.
5. When experiments and trials must be carried along in connection with such parts.
6. When it is sound practice to keep the plant's own local, skilled workmen busy.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company
Niagara Falls, N. Y.

SOMETIMES it is more or less difficult to arrive at a true picture of the actual money involved in a replacement. Those who have followed the ideas presented from time to time in the articles on maintenance costs will find this less difficult than will others. These articles have pointed out costs from loss of production as well as direct time and material. The cost system or the fundamental data from which the costs are obtained also show the parts requiring replacement.

The records of the maintenance department on these replacements form the basis for the storeroom to determine the material to be carried in stores. The engineering department and purchasing department, in conjunction, are in a position to determine whether the material should be made by their shop or purchased outside. The quantities required, the delivery dates, and such matters can be worked out ahead of time.

There can be no question about some replacement parts. For example, where a belt is part of a machine, spare stock is carried as a matter of course. This is perhaps an extreme case, but the same factors enter into the replacement of any part. The shop making a large number of parts can have the advantage over those making a few. This is, of course, particularly true of castings, special alloy parts, and stampings.

On the other hand, there are some parts that can be made in the plant shop satisfactorily and at a saving in cost. Shafts and parts requiring considerable labor are examples of those falling in this category. There are also special devices developed in every plant which should be made in the plant shop. The use of welding is an important adjunct that should be considered in repairing parts.

The question of keeping the force busy should not be considered. Usually a job that is used simply for the purpose of having something to do is costly. Where spares are being made in the shop they should be handled as though they were given to an outside concern. This procedure insures the inspection, accuracy, and speed needed to meet estimated costs.

J. P. SIMONS, *Plant Engineer*
Industrial Rayon Corporation, Cleveland

THERE is no one answer to this question except to obtain the parts needed as cheaply as possible, all things considered. In general, replacement parts split into two classes: Those steadily required as supplies because of normal wearing out in service; and extraordinary repairs on account of accidental breakage.

For the first class, quite a bit of attention can be given to finding out how they can be improved in material or design to increase life, what they can be made for in the shop itself or on contract in shops other than the original makers, and a supply arranged for accordingly.

In underfeed stoker tuyeres, for example, although they are an article of steady consumption, only the largest plant could afford to spend the time and money to perfect the patterns, gages, and machine molding to give the desired fit without excessive hand work.

The second class, parts to take care of accidental breakage, are needed so irregularly and in such small quantities that usually the question of how soon that part is needed and how it can be obtained is the deciding question. Welding has solved this problem in a great many cases as it is possible to patch up a piece as good as ever and get the machine going again while thinking about sending a pattern to the foundry or an order to the machine builder.

Operating conditions of an industry also affect its policy regarding repair parts supply. In our own plant, operating 24 hours a day, 4 or 5 days a week, with a continuous process which makes the whole mill in effect one big machine, the size of the repair force is based chiefly on having enough help to make the necessary repairs and adjustments while the machinery is shut down over the week-end. Thus, apart from breakdowns and working on such parts of the production equipment as can be spared temporarily, there is more or less spare time for the repair force and we try to use this in the making of repair parts for which the makers ask unreasonably high prices.

Some prices quoted on by the machinery makers have been ridiculous; for instance, $16 for a 16-tooth, 4-pitch, solid, cast-iron spur pinion about 2-in. face, which could be bought from a local machine shop for $4. While it undoubtedly costs the manufacturer money to stock parts, such a spread as this seems too large. The policies of different firms vary a great deal, but the trend seems to be toward more moderate prices for repair parts so that where they are at all special, or only one or two are needed, the user can hardly afford to make them unless to save an expensive shutdown.

H. D. FISHER, *Plant Engineer*
New Haven Pulp & Board Company
New Haven, Conn.

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

What Code for the Electrical Service Shop?

Is there any national organization through which electrical service and repair shops are being coded in compliance with the spirit of the National Industrial Recovery Act?

F.R.P.—*Columbus, Ohio*
W.L.S.—*El Paso, Texas*
H.W.Z.—*Austin, Texas*
T.M.G.—*Johnstown, Pa.*

THE EXISTING national organization which seems to have a natural relationship to the electrical service and repair shops is the National Electrical Contractors Association, with headquarters at 420 Lexington Avenue, New York City. The General Manager is Laurence W. Davis. For more than seven years this organization has included a division known as the National Motor Specialists Section with its own National Chairman.

The N.E.C.A. has filed a preliminary draft of a code with the National Recovery Administrator. This code defines the electrical contracting industry to mean "the business of selling and/or installing or repairing electric wiring, devices, appliances, or equipment." It also says that the electrical contractor "shall be generally qualified by his technical training, and/or experience in the industry, to direct properly the installation or repairing of electric wiring, devices, appliances, or equipment."

Problems peculiar to the motor service and repair business, such as the establishment of a proper basis for selling reconditioned motors, and the basis of prices for rewinding motors, exist. They require both local and national study. Probably they can be made the basis for either a supplemental code or supplemental regulations under the code of the N.E.C.A.

As we go to press we learn that the National Committee of the N.E.C.A. has asked the N.R.A. to include in the Association's basic code revisions that will cover the needs of the electrical service and repair shops.

EDITOR.

Restoring Idle Belts to Service

Will readers please tell me: (1) Do flat leather and rubber belts and rubber V-belts deteriorate seriously during prolonged idleness? (2) Are belts that have been idle for a year or more likely to have been injured by allowing them to remain on the pulleys, under normal tension? (3) What attention do leather and rubber belts that have been idle for some time require before they can be put back into service?

A.E.S.—Boston, Mass.

FLAT LEATHER and rubber belts and rubber V-belts should not materially deteriorate due to idleness if properly cared for. The rubber naturally deteriorates rapidly if stored under hot conditions, and temperature also affects leather belting. Oil and dirt are harmful to all types of belts. If a belt is put into storage in an oily condition it deteriorates rapidly. Belts should be cleaned and packed to protect them from dirt, then stored under cool dry conditions.

Belts that are allowed to remain idle on the pulleys are apt to deteriorate. Leather and rubber are both elastic materials and should not be left under tension.

(Continued on advertising page 32)

ANSWERS WANTED

Penalizing Maintenance Department for Equipment Failures

We operate a metal-working plant and are considering charging against the maintenance department the cost of production delays caused by trouble with equipment for which it is responsible. These questions have come up: (1) Is such a plan inherently unfair? (2) Can it be applied successfully? (3) Are there any real advantages to it? (4) Do other plants have such a plan in force? (5) Should any allowances or exceptions be made in cases of equipment failure that can not be traced to neglect or improper care by the maintenance department?

H.E.W.—*Detroit, Mich.*

Solder for White Metals

I should like to know whether aluminum-base and zinc-base white metals, used for die castings, can be soldered successfully. If so, what kind of solder is used? Is a special flux needed? Any special precautions? *W. S.—New York, N. Y.*

Trouble With Magnetic Switches

What conditions will cause magnetic switches to hum, flash excessively, and stick frequently? These troubles are apparent with several of our 440-volt switches, although the loads they are carrying are well within their rating. *J.A.D.—St. Louis, Mo.*

Dual-Voltage Connections for Induction Motors

Three-phase star series and parallel connections, twenty to twenty-four poles

(Continued from the August issue)

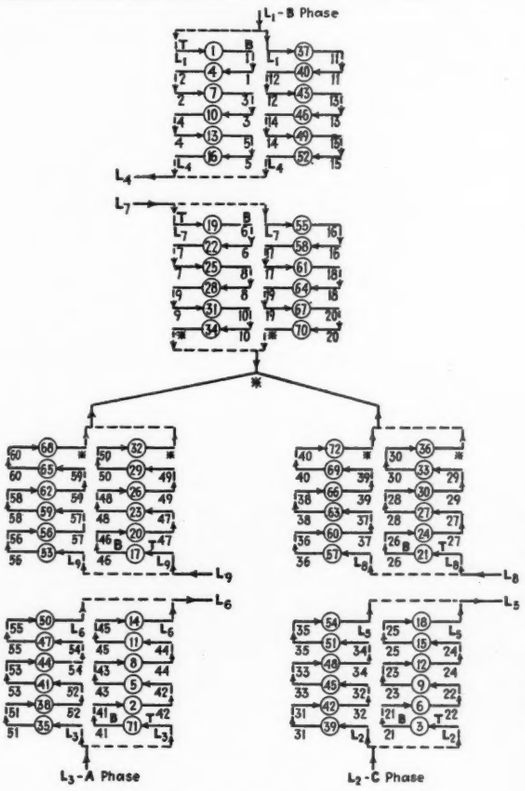

Figure 8. Three-phase, 24-pole, two and four-parallel star

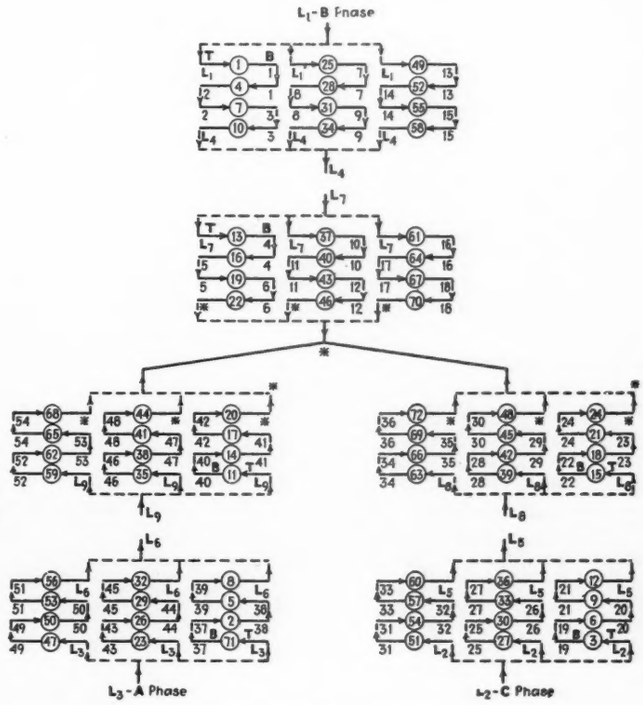

Figure 9 Three-phase, 24-pole, three- and six-parallel star

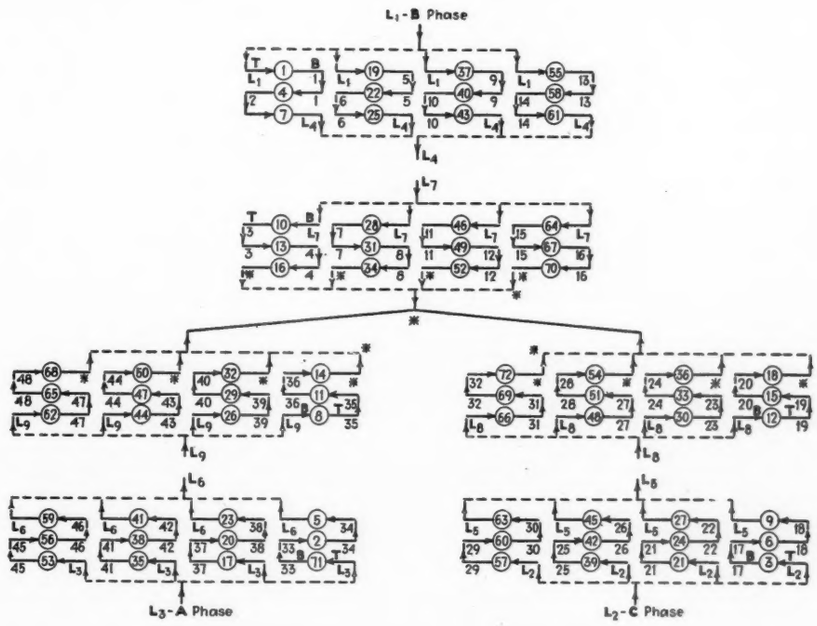

Figure 10. Three-phase, 24-pole, four- and eight-parallel star

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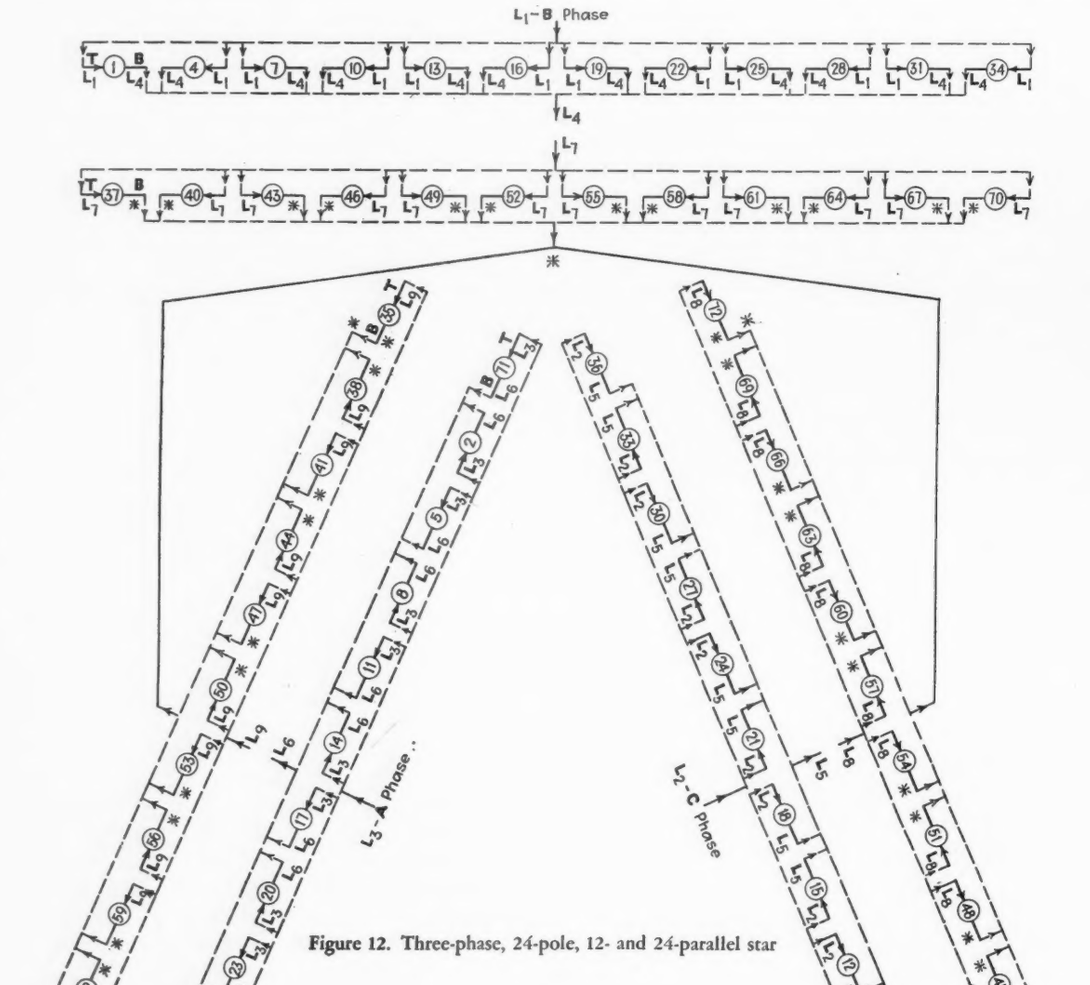


Figure 12. Three-phase, 24-pole, 12- and 24-parallel star

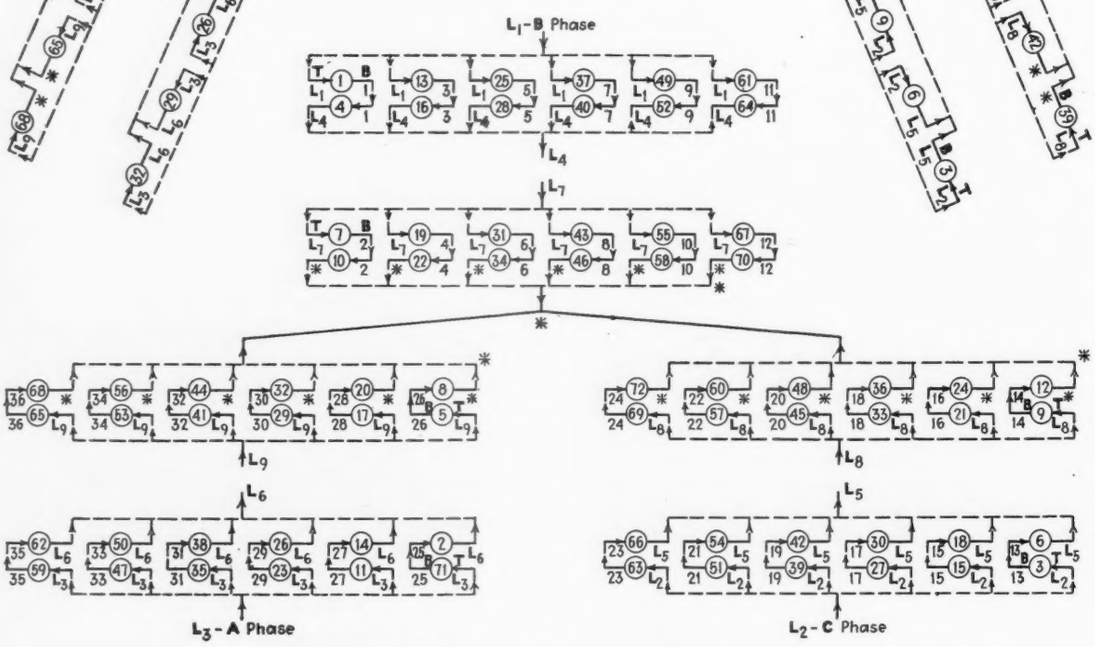
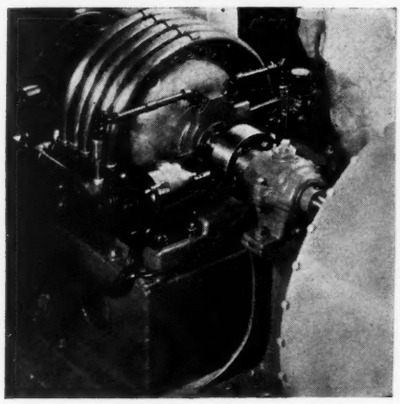


Figure 11. Three-phase, 24-pole, six and twelve-parallel star

·EQUIPMENT NEWS·



Hydraulic Coupling

For variable-speed control with constant-speed driver. Designed for use with simple induction motor to replace slip ring motor in centrifugal pump operation. Said to eliminate loss of power incurred where throttle valves are used. Infinite number of speeds. Delivers 13 hp. at 3,600 r.p.m. American Blower Corp., Detroit, Mich.

Timer

Type TSA-10, automatic, Telechron-motor-operated, for use on a.c. circuits. Timing started by closing switch; resetting automatic when control circuit is de-energized. Timing period readily adjustable over wide range. Can be arranged to operate signal or terminate a process at end of predetermined period. Has two scales, graduated in hours or minutes according to rating, one scale having range three times that of the other. General Electric Co., Schenectady, N. Y.

Drill

Light-duty, $\frac{1}{4}$-in. electric, equipped with ball bearings on both ends of armature. Hand-wound and formed coils. The Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.

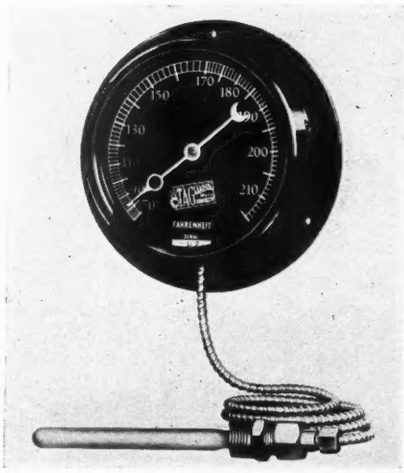
Clamp

"Bull Dog," for centering and holding pipe ends in proper relation for welding. Made in two sizes to take pipe from 4 to 6 in. and from 8 to 12 in. One lever controls action of clamp. Open construction leaves space for tacking. Oster-Williams, Cleveland, Ohio.

Cable

Rubber-insulated with heat-, corona- and moisture-resisting compounds. Type GE-R359, designed to operate at maximum temperature of 75 deg. C., recommended for insulating cables for station, apparatus, transformer lead, motor load, and power applications demanding cable insulation capable of standing high temperatures. Type GE-R348, designed for wet locations, such as non-leaded submarine cables. Not corona-resisting. Type GE-R351 is both corona- and moisture-resisting. Recommended for cable for high-voltage transmission, distribution, station, apparatus, parkway, tree-wire, serial, and submarine service. Has high di-electric properties. General Electric Co., Schenectady, N. Y.

Thermometer



Five-inch dial, indicating. Has bellows suited to vapor tension ranges between minus 40 and plus 335 deg. F. Indicating pointer actuated by motion of bronze bellows which expand and contract at temperature changes of bulk. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

Experimenting Kit

Photoelectric, for those who prefer to do their own experimenting with photoelectric control for mechanical equipment, operations, and processes. Called the "Photronic Control Kit," it contains all equipment necessary for smoke detection, burglar alarm, turbidity detection, door opening, counting, operation of safety devices on machines, and other services. The "Photronic Cell," included, transforms light energy directly into electrical energy and operate relays without use of auxiliary apparatus or batteries. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Pulleys

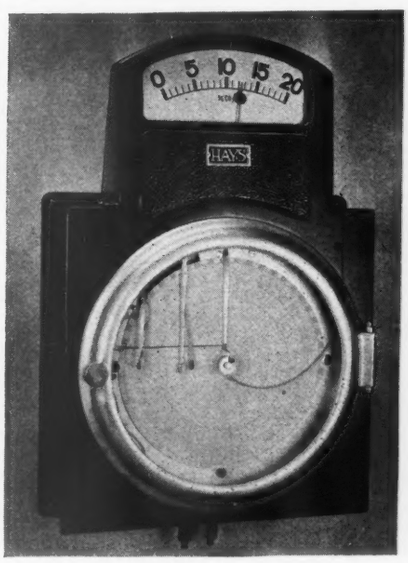
For A- and B-type V-belts. Die cast from white brass, diamond bored, and balanced to eliminate vibration at high speeds. Variety of sizes. The Congress Tool and Die Co., Detroit.

Foam Generator

For converting fire line from continuous water stream to continuous foam stream. "Phomene Hopper" is coupled into hose line, water enters at one side, "Phomene Powder" is poured in hopper, and foam stream emerges from nozzle. Designed for industrial service where quantities of flammable liquids are used or stored. Hopper has no levers, valves, gages, or moving parts. Weight, 42 lb. Claimed to operate efficiently with water pressure as low as 35 lb. Pyrene Mfg. Co., Newark, N. J.

Recorder-Indicator

For measuring CO_2 content of flue gas. Operates on Orsat principle. Continuous stream of flue gas is drawn rapidly from last pass of boiler. At regular intervals machine takes meas-



ured sample, causes CO_2 to be absorbed, and records amount of absorption. Pointer indicates CO_2 content for visible reading at normal distance. Pen and pointer both hold positions until change must be recorded. Instruments also available for recording overfire draft and flue gas temperature on same 10-in. chart with CO_2 record. The Hays Corp., Michigan City, Ind.

Phototube

Vacuum-type, made in automobile-headlamp bulb, and fitted with standard, single-contact, bayonet-type base. Type FJ-114 claimed to have same sensitivity as usual gas tube and stability of usual

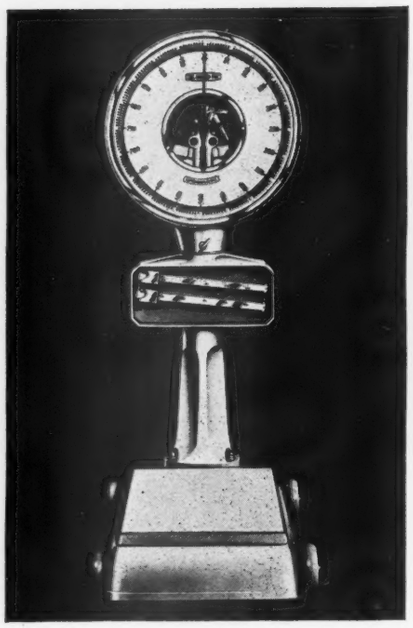
vacuum tube. Increase of infra-red sensitivity enables tube to respond to heat from body not even glowing in the dark (wave length beyond 12,000 Angstroms, temperature about 900 deg. F.). General Electric Co., Schenectady, N. Y.

Screw Driver

"Super-grip." Lacquered maple handle with deep, machine-cut grooves. Blade of high-carbon steel, fastened to handle without pins by method claimed to prevent turning. Made in 3-, 4-, 5-, 6-, and 8-in. sizes, machinist's type, with blade part through or clear through handle. Electrician's type made in 4½-, 6½-, and 8½-in. sizes. The Forsberg Mfg. Co., Bridgeport, Conn.

Unloader

Automatic, instantaneous, for small refrigerating compressors. Consists of pressure-differential-operated by-pass valve connected between suction and discharge on compressor. Valve is controlled by magnetic pilot valve in turn controlled by frequency-responsive relay on motor starting panel. Electric Machinery Mfg. Co., Minneapolis, Minn.



Scale

Portable. Platform 21x29 in. Plate does not overhang suspension loop. Levers have no lateral movement. Four-wheel construction. Wheels of Bakelite and rubber. Three-wheel construction furnished if desired, and scale fitted with handle for movement about plant. Ball bearings, 1-cam translation mechanism. The Kron Co., Bridgeport, Conn.

Conveyor Chain

All-steel, for bottling, packaging, and similar machinery which requires built-in conveyor chain. Roller-type. Pitch dimension double that of standard roller chain. Furnished in combinations of stainless steel parts or in all-stainless-steel construction. The Whitney Mfg. Co., Hartford, Conn.

Instruments

Type AP-9, portable, electrical, including medium-sized voltmeters, milliammeters, ammeters, and wattmeters. Textolite cases with hinged covers and snap locks. 2½x6½x4¾ in. Supersedes Type P-8 line. Length of scale in mean arc, 4¼ in. Accuracy, 0.75 per cent of full-scale value, except in case of triple-range voltmeters when it is 1½ per cent. May be used for either d.c. or a.c. measurements, except three- and four-range ammeters which have internal transformer. Voltmeters and ammeters employ Thomson inclined coil; wattmeters are constructed on electrodynamic principle. General Electric Co., Schenectady, N. Y.

Door

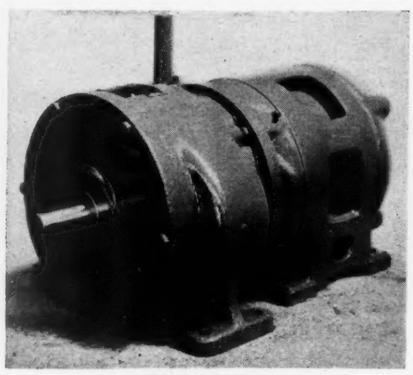
"Durabilt," overhead, metal. Hollow-steel construction. Counter-balanced by means of encased compression spring. Cables are steel, airplane-type. Closing device has lever action permitting door to rest in vertical position when closed. Can be operated electrically. Weather strips on all sides. Fire resisting. Durabilt Steel Locker Co., Overhead Metal Door Division, Aurora, Ill.

Drive

"Worthington Multi-V," now employs improved type of "Goodyear Emerald Cord V-belt," claimed to have high power capacity, long flexing life, uniform cross-section, and low stretch. Worthington Pump and Machinery Corp., Harrison, N. J.

Motor Reducers

Davis & Thompson Co., 6619 W. Mitchell St., Milwaukee, Wis., has purchased assets of Planigressive Reducer Co. and has redesigned the complete line which includes "Planigressive" reducers with standard reduction ratios from 3:1 to 600:1. Sales handled through Planigressive Reducer Sales Co., Milwaukee, Wis.



Crane and Transfer Bridge

For loads up to one ton where the bridge span is not over 16 ft. Suitable for hand-propelled carriers, either with or without chain- or motor-operated hoists. For operation on runways of Cleveland Tramrail standard rail or arch beam. Designated as Type CHS or CHSE crane and THS or THSE transfer bridge, constructed of section of tramrail 8-in. arch-beam rail, used as crane bridge, and standard one-ton hand-propelled carriers as end trucks. Latter are keyed to beam to prevent misalignment. Electrical fittings can be added at any time for motor-operated hoists. Cleveland Tramrail Division, Cleveland Crane and Engineering Co., Wickliffe, Ohio.

Rail

Eight-inch, arch-beam, 2,400 series. Designed to fill need for self-supporting rail capable of supporting loads up to 2 ton. Identical in construction with 10- and 11½-in. arch beam. Non-peining. Ball-and-socket method of suspension. Rail built of half section of structural-steel beam, with semicircular holes punched in web, and standard high-carbon steel tramrail rail welded to beam. The Cleveland Tramrail Division, Cleveland Crane and Engineering Co., Wickliffe, Ohio.

Flux

Oxweld Aluminum, for all-purpose aluminum welding. Intended to replace two fluxes previously marketed, one for welding pure aluminum, other for welding aluminum alloys. Packed in ¼-lb. jars. The Linde Air Products Co., 30 E. 42nd St., New York.

Instruments

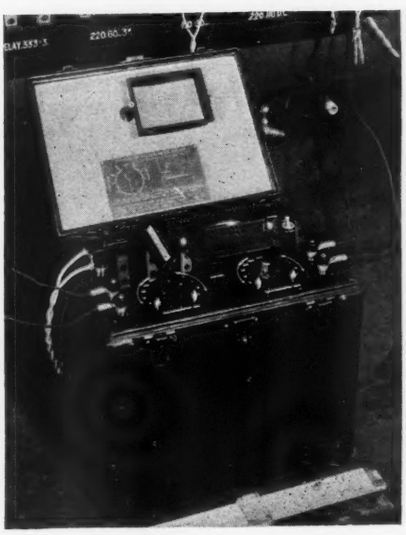
Direct-reading, precision, hair operated, for indicating and recording humidity and air conditions. Type 500, indicates relative humidity, available in 3- and 4-in. dial sizes. Type 502 (Polymeter) indicates relative humidity, air temperature, maximum vapor pressure, dew point, absolute humidity, and saturation deficit. Type 504 (Thermo-hygro meter) indicates relative and absolute humidity, air temperature, dew point, maximum vapor pressure, and saturation deficit. Pointer is thermometer tube. Type 520 (Hydrograph) records percentage of relative humidity. Multiple-human-hair operating element exposed to atmosphere but mounted inside portable case 10x5x9 in. with glass-enclosed chart movement. Type 525 (Thermograph) records air temperature. Bi-metal coil operating element. Case 10x5x7 in. Type 530 (Thermo-hygrograph) for recording both relative humidity and air temperature. Combines features of Types 520 and 525. Amthor Testing Instrument Co., Inc., 309 Johnson St., Brooklyn, N. Y.

Nozzle

"Rex," spray. For washing and cleaning operations. Gives flat spray, free from mist. In two sizes: 1/32-in.-diameter throat at discharge, 4½ in. long overall; and ⅛-in.-diameter throat at discharge, 2½ in. long. Chain Belt Co., Milwaukee, Wis.

Oscillograph

Portable. Self-contained. Operates from 110-volt, 60-cycle lighting circuit without auxiliary attachments. Over-all dimensions, 8x11½x11 in. Weight 18 lb. The two galvanometers may be used for measurements of potentials up to 300 volts or currents up to 10 amp. without external resistors. Simultaneous viewing and photographing. Continuous time axis furnished by small revolving mirror with variable speed. Galvanometer has electro-magnetic damping. Optical system magnifies galvanometer deflections and permits viewing trace in lighted room. Westinghouse Electrical & Mfg. Co., East Pittsburgh, Pa.

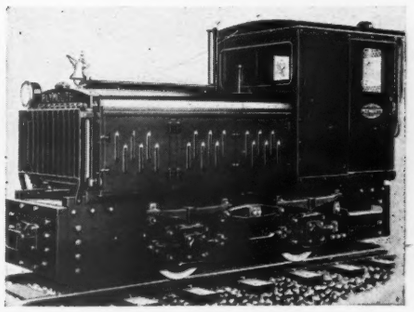


Motors and Controls

Splash- and drip-proof. Complete line for all machine requirements. Especially suited for meat packing plants, canneries, breweries, paper mills, boiler rooms, coal yards, and wet grinding processes. Motor windings protected by double insulation. "Sealed-Sleeve" bearings standard; ball bearings furnished if desired. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locomotive

Ten-ton, diesel-powered. Six-cylinder power plant is solid injection type with 4⅞-in. bore and 6-in. stroke, developing 95 hp. at 1,200 r.p.m. Two types of



drives; mechanical gear in sizes from 6 to 60 tons, and diesel-electric in sizes from 25 to 60 tons. Four-speed transmission gives same speeds both forward and backward. The Fate-Root-Heath Co., Plymouth, Ohio.

Slings

Wire rope. Single- and multiple-part. Can be made up in various combinations to suit material to be handled. Ten general types make possible wide variety of combinations. "Atlas" and "Drew" slings are multiple-part, braided. "Monarch" is single-part. Macwhyte Co., Kenosha, Wis.

Switch

Oil-immersed, combination, explosion-proof, for use in Class I, Group D hazardous gas locations. CR7008 is available in three sizes for motors up to

50 hp. at 440 volts. Suitable for use in paint factories, lacquer plants, oil refineries, chemical houses. Weatherproof for out-door location. Switch consists of three parts: magnetic switch, motor-circuit switch, and thermal overload relay which is reset by plunger extending through top cover. These parts, and all connections, are 6 in. below surface of oil in welded tank. General Electric Co., Schenectady, N. Y.

Caster

"Forgeweld," for heavy loads and easy operation. Top plate, yoke base, and button of drop-forged steel. Yoke cut from structural steel. Hyatt roller bearings, and Alemite-Zerk lubrication at two points, regular equipment. Height from floor to top plate, 5⅝ in. to 7½ in. Wheels furnished in semi-steel, Textolite, Enduro R.T., and aluminum alloy, in sizes 4 in., 5 in., and 6 in. The Service Caster & Truck Co., Albion, Mich.

Mask

"Healthguard," Style No. 601, for sandblasting and similar work involving danger from silicosis. Rated 99 per cent efficient by manufacturer. Consists of soft molded rubber facepiece designed to adapt itself to any facial contour, sealing against outside air and dust. Facepiece held in place by molded rubber head harness with adjustable buckles. Attached to facepiece is molded flexible rubber tube which connects with air filter attached to belt and connecting to air supply. Exhaust tube contains fully automatic relief valve and leads to back of head. Chicago Eye Shield Co., 2300 Warren Boulevard, Chicago.

Switch

Metal-clad, for service up to 15 kv. three-pole, group-operated, for industrial plants. Three switch blades carry fuses interlocked and simultaneously opened and closed by means of locking-type external handle. Screened opening permits inspection of fuses and ventilation for equipment. Panel above opening for removal of blown fuses. Delta-Star Electric Co., Chicago, Ill.

Coupling

Roller-chain, flexible, for direct-drive applications. Consists of two accurately cut roller-chain sprockets coupled together with Whitney roller chain. Clearance between sprockets allows for slight shaft misalignment and gives reasonable amount of motor end float without binding or shaft distortion. Construction permits quick installation or dismantling of equipment. Rotating-type coupling cover insures proper lubrication and protection from dirt. Whitney Mfg. Co., Hartford, Conn.

Sandpaper

Made by electrostatic process. Said by manufacturers to permit increased speed, to prolong life, and improve efficiency from 20 to 60 per cent. Made with all familiar abrasives, including garnet, aluminum oxide, and silicon carbide. Armour Sand Paper Works, Behr-Manning Corp., The Carborundum Co., and Minnesota Mining and Manufacturing Company.

Motor

Totally-inclosed, fan-cooled. Provides full protection against explosive or abrasive dust, corrosive gases or fumes, steam, or moisture. Construction employs two shells—inner shell dust-tight and inclosing windings and rotor. Fan forces blast of air between shells. Made in all sizes from 1 to 200 hp. as squirrel-cage induction motors to meet all classifications of torque and inrush requirements and with 1, 2, 3, or 4 speeds. Available also as across-the-line-start motors up to 200 hp. and can be supplied for power-factor correction as 100 per cent or 80 per cent leading power factor induction motors in all sizes. The Ideal Electric & Mfg. Co., Mansfield, Ohio.

TRADE LITERATURE

AIR CONDITIONING EQUIPMENT—Catalog, 18 pages, "Sturtevant Air Conditioning, Heating, Humidifying, Ventilating, Cooling, Dehumidifying."—B. F. Sturtevant Co., Hyde Park, Boston, Mass.

BALSA WOOD—Bulletin, 8 pages, "The Story of Lata Balsa, Its Growth, Characteristics, Properties, Applications."—The Balsa Wood Co., Inc., Brooklyn, N. Y.

BELTS—Catalog, 48 pages, "Serving Industry's Needs in the Handling of Materials and the Positive Transmission of Power by Link-Belt."—Link-Belt Co., Chicago, Ill.

BELT IDLERS—Bulletin No. 569, 12 pages. The Jeffrey Mfg. Co., Columbus, Ohio.

BLOWERS — Bulletin 21-B16, "R-C-W Victor-Acme Blowers."—Roots-Connersville-Wilbraham, Connersville, Ind.

BRUSHES—Catalog No. 185, 32 pages, "A Guide to the Industrial Application of Osborn Brushes."—The Osborn Mfg. Co., 5401 Hamilton Ave., Cleveland, Ohio.

CIRCUIT BREAKERS—Leaflet 20565, "Type FO-22 Oil Circuit Breakers."—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLEANING, FINISHING — Booklet, 48 pages, "Tumbling, Rolling, and Barrel Burnishing."—Magnus Chemical Co., Garwood, N. J.

COMPRESSORS AND EQUIPMENT—Form 1604E," Portable Compressors, Tools, and Equipment." — Ingersoll-Rand Co., 11 Broadway, New York.

CONTROLLERS—Bulletin No. 1020, "Floating Type Valveless Automatic Controllers for Atmosphere and Temperature in Oil Burning Furnaces."—Johnston Mfg. Co., Minneapolis, Minn.

COUPLING—Bulletin No. 500, 8 pages, "Falk-Rawson 4-Duty Coupling."—The Falk Corp., Milwaukee, Wis.

DRAFTING ROOM FURNITURE—Catalog, 60 pages, "Hamilton Drafting Room Furniture Including the Calumet Plan File System." —Hamilton Mfg. Co., Two Rivers, Wis.

FAN—Catalog, looseleaf, "Roto-Beam Air Circulator."—Motor Service Mfg. Co., 3300 Indiana Ave., Chicago, Ill.

FURNACES—Bulletin No. 8, 4 pages, "Ajax-Northrop Furnaces for Melting and Heat Treating." — Ajax Electrothermic Corp., Trenton, N. J.

GAGES—Catalog No. 6702, includes, thermometers, pressure and vacuum gages, and liquid-level gages.—The Brown Instrument Co., Philadelphia, Pa.

GEARED MOTOR REDUCER—Bulletin, "An Answer To a Century Old Problem," describes the Sterling system of infinite speed variation.—Sterling Electric Motors, Inc., Los Angeles, Cal.

HEATER—Bulletin No. 6, 8 pages, "Convectofin Takes the Place of Radiators."—Commodore Heaters Corp., 11 W. 42nd St., New York, N. Y.

LUBRICATION—Bulletin, 18 pages, "E. P. (Extreme Pressure) Lubrication."—Technical Division, Standard Oil Co. (Indiana), Chicago, Ill.

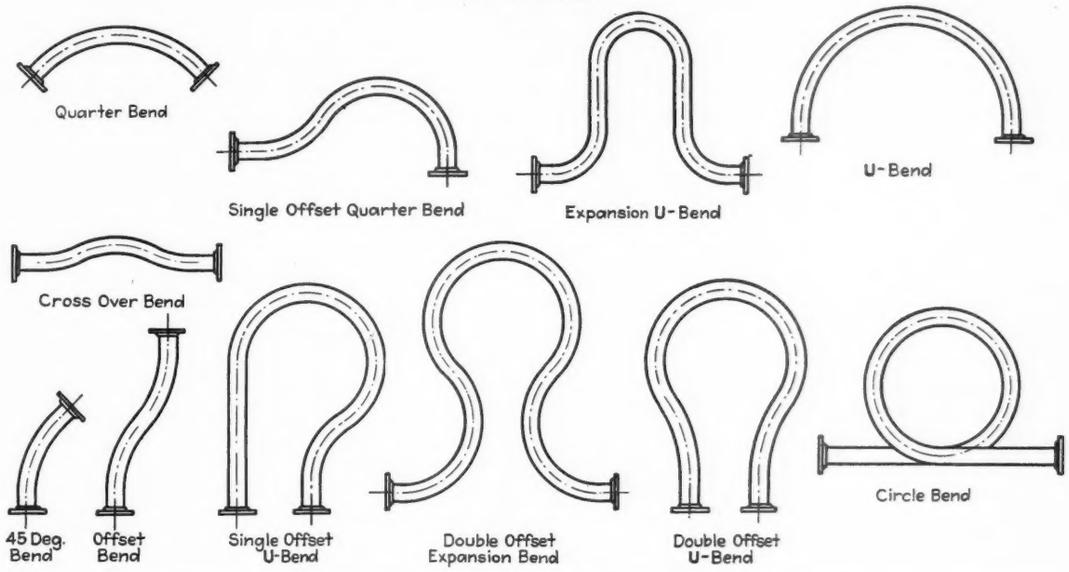
LUBRICANTS—Bulletin No. F92, "Colloidal-Graphited Lubricants." — Acheson Oildag Co., Port Huron, Mich.

MOTORS—Leaflet 20580, "Type FH Resistence Split-Phase Motors."—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

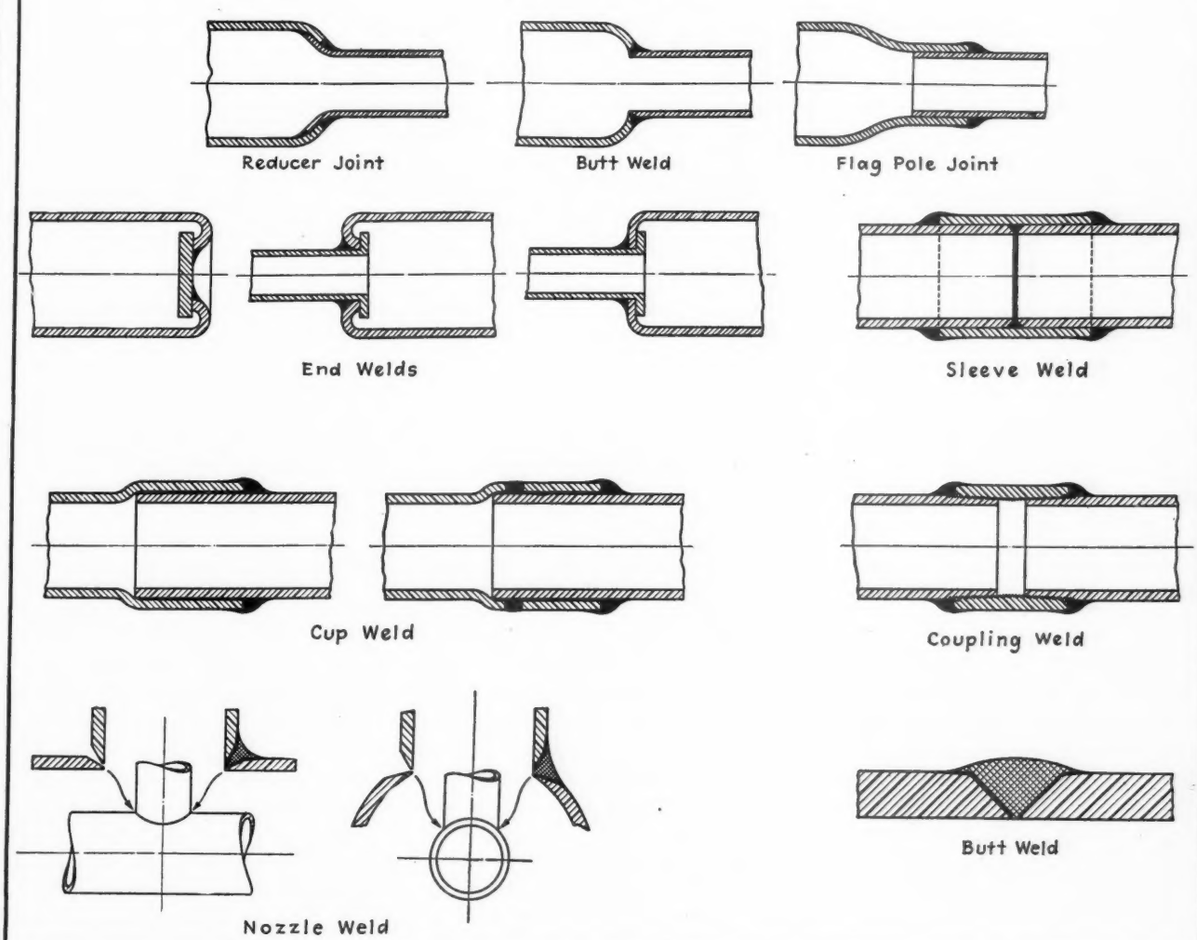
MOTORS—Leaflet 20537, "Type G High Speed Synchronous Motors."—Westing-

(Continued on advertising page 30)

PIPE BENDS



WELDED JOINTS



Data Sheet

Pipe Fittings - *Flanged*

	Aluminum	Asbestos and Cement	Brass	Cast Iron	Cast Iron *bell and spigot end*	Hydraulic	Lead	Malleable Iron	Rubber	Silicon Iron	Cast Steel	Forged Steel	Wood
Bend, 1/64					20-60								
" 1/32					3-60								
" 1/16					3-60								
" 1/8				4-12	3-60								
" 1/4					3-48								
" return					1-18					1-8			
Cap					3-54						1 1/4-24		
Cross	1-8			1 1/4-48	3-60		3/4-8		1/4-5	1-8	2-24	1-4	2-8
" reducing				1 1/4-48	3-16								
" side outlet				1-24									
" base anchorage				1-24									
Coupling		2-36											
Elbow, long sweep	1-8		1-6	1 1/4-24	1 1/4-48	3/4-6	3/4-8				1 1/4-24	1-4	
" base				4-24	3-54						4-16		
" Taper reducing				1 1/2-24	3-48						1 1/4-16		
" double branch				4-16									
" D.B. reducing				4-16									
" side outlet				4-16									
" S.O. reducing				4-16									
" 90-deg.	1-8	2-12	2-6	1 1/4-48	1 1/4-14	3/4-6	3/4-8		1-6	1-8	1 1/4-24	3/4-24	2-14
" 60-deg.	1-8				1 1/4-2				1-6	1-8	1 1/4-24	3/4-24	
" 45-deg.		2-36		1 1/4-30			3/4-8				1 1/4-24		
" 22 1/2-deg.					1 1/4-12								
" 11 1/4-deg.				3-54	1 1/4-10								
" 5 5/8-deg.				3-54	1 1/4-10								
Flange, blank	1/4-10			1 1/4-32				1/4-2 1/2		1-12	1/4-2 1/2	1/4-2 1/2	
" companion	1/8-4			4-32	1-6						1/4-12	1/2-12	
" com. reducing				7-12				3 1/2-6			3/8-4	7-12	
" grooved				1 1/2-12									
" slip-on												2-24	
" hub												2-12	
" Van Stone												2-12	
Lateral, 45-deg.	1-8			2-48	3-48						2-24		
" reducing				2-24	3-48						4-18		
" Y				2-12	3-48								
Offset				4-12	4-24								
Plug					3-54								
Reducer, taper	1-8	2-36		2-24	3-60		2-8			1 1/2-8	2-16	1-4	
" eccentric				2-24	3-48						2-14	1-4	
Sleeve		2-36		1-8	3-60								
Tee	1-8	2-36	1-6	1 1/4-24	3-60	3/4-6	3/4-8		1-6	1-8	1 1/4-24	3/4-6	2-14
" base				1-24	3-54								
" double sweep	1-8			1 1/4-24	3-48						2-24		
" D.S. reducing				3-48	1 1/2-58						2-24		
" reducing	1-8			1 1/2-24							2 1/2-24		
" side outlet	1-8			4-16	3-48								
" S.O. reducing				4-16									
" side anchor				1-24									
Union, flange												1/4-8	

Welding Fittings (Steel and Wrought Iron)

Elbow	90-deg.	3/4-24
"	45-deg.	3/4-24
"	long sweep	1-12
Flange	companion	1-24
"	slip on	2-48
"	neck	1-24
Head		1 1/2-24
Nipple	Van Stone	2-16
Cap		3-12

Welding Fittings (Steel and Wrought Iron)

Plug		3-12
Reducer		1-12
"	eccentric	1-12
Return bend		3/4-20
Saddle		2-24
Sleeve		4-24
Tee		1-24
"	reducing	1-8

Data Sheet

Pipe Fittings - Screwed

	Aluminum	Brass	Cast Iron	Ceramic	Christmas Tree	Chrome Nickel	Hydraulic	Lead Lined	Malleable Iron	Hard Rubber	Steel	Sweated and Compression	Tin Lined
Bend, 60-deg.									3/8-4				
" 90-deg.	1-12											1/2-2	
" 180-deg., close	1/4-4	1/2-4	1/2-4						1/2-2				
" 180-deg., medium			1/4-4						1/2-2	1/4-5			
" 180-deg., open		1/2-3	3/4-4					1/2-3	1/2-3				
" 180-deg., back outlet			3/4-3										
Bushing	1/8-4	1/4-4	1/4-12				1/4-2		1/4-2 1/2		1/4-6		
" eccentric			1/2-1 1/4										
" face		1/4-4							3/8-12		1/4-6		
Cap	1/8-4	1/8-4	2 1/2-12	1-20			1/2-6	1/2-6	1/8-6	1/4-5	1/8-8	1/8-6	1/2-3
Connection			2-10										
" roof			2-6										
Cross	1/8-4	1/8-8	3/8-12	1-10	2-12		1/4-4		1/8-10		1/8-4		1/2-3
" reducing	1 1/4-3	1/2-4	1/2-12										
Crossover		1/2-1							1/2-1				
Coupling	1/8-6	1/8-4	1/8-12			1 1/2-8	1/4-4	1/2-6	1/4-4	1/4-5	1/8-4	1/8-6	
" boiler									1/2-3/4				
" reducing									1-4		1/8-4	1/8-6	
" R. and L.		1/8-2	1/4-3						1/4-2				
Elbow, 90-deg.	1/8-5	1/8-8	1/4-12	1-12	2-12	1 1/2-8	1/4-4 1/2	1/2-6	1/8-12	1/4-5	1/8-6	1/8-6	1/2-3
" 60-deg.		1 1/4-2	1/4-12						1 1/4-2				
" 45-deg.	1/8-5	1/8-8	1/4-12	1-12				1/4-4 1/2	1/4-12	1/4-5	1/8-4	1/8-6	
" 22 1/2-deg.			1 1/4-12										
" 11 1/4-deg.			1 1/4-10										
" 5 5/8-deg.			1 1/4-10										
" base			3-12										
" double branch			1-12										
" drop		3/8-2											
" drop, female			1/4-3/4						1/4-3/4				
" male & female			3/8						3/8			3/8-1 1/4	
" flanged											1/4-1 1/4	1/4-1 1/4	
" heel outlet			4										
" reducing	1/4-4	1/4-8	3/8-12						1/4-1 1/2			1/8-6	
" R. and L.		1/4-3							1/4-2				
" side outlet		3/8-2	1/2-12						3/8-2				
" street, 90-deg.	1/8-5	1/8-4					1/4-2		1/8-4	1/2-2	1/4-1 1/4	1/8-6	
" street, 45-deg.	1/8-5	3/8-2	1 1/4-2						3/8-2			1/8-6	
" 3-way			1 1/4-6										
" and female union									1/4-2 1/2		1/2-2 1/2		
" and male union									1/4-2 1/2		1/2-2 1/2		
Extension		3/8-2							3/8-2				
Hanger, closed			1/2-8										
" open			1/2-8										
Increaser			1-10										
Nut, lock	1/4-4	1/8-4	2 1/2-12						1/8-3				
" waste		1/4-2							1/4-1 1/2				
Offset									3/4-1 1/4				
Outlet, plain	1-10												
" threaded	1-12												
Plate, expansion			1-2						1-2				
" hook			1-2						1-2				
" ring			3/8-2						3/8-2				
Plug, co. sunk		1/2-2	1/2-6						1/4-6				
" L.H.			1/2-2										
" solid		3/8-4											
" sq. head	1/8-6	1/8-4	1/8-12				1/4-2	1/2-6	1/8-4	1/4-5	1/8-4		
Reducer, 1/8-6	1/4-4	2-12	4 1/2-12						1/4-12			3/8-1 1/4	
" eccentric			1 1/4-8								1-2		1/8-3
Tee, 90-deg.	1/8-5	1/8-6	1/4-12	1-12	2-12	1 1/2-8	1/4-4 1/2	1/2-6	1/8-6	1/4-5	1/8-6	3/8-1 1/4	

Continued on following page

Data Sheet

Pipe Fittings - *Screwed - continued*

	Aluminum	Brass	Cast Iron	Ceramic	Christmas Tree	Chrome Nickel	Hydraulic	Lead Lined	Malleable Iron	Rubber	Steel	Sweated and Compression	Tin Lined
Tee, basin			1¼-2¼										
" branch			1-2										
" drop, female		3/8-¾							3/8-¾				
" drop, male & female		3/8							3/8-1				
" drop, female union									¼-2½		½-2½		
" drop, male union									¼-2½		½-2½		
" four-way		3/8-2							3/8-2				
" reducing	¼-4	¼-4	¼-12						3/8-12				
" service									¼-3				
" street		3/8-2							¼-3				
" two pipe		1-2											
" wash tray		½-¾							½-¾				
Union, plain	⅛-4	⅛-4					¼-3	½-4	⅛-4	¼-5	⅛-3		½-3
" boiler									½-¾				
" flange			½-12				¼-8		¼-8				
" male & female									¼-2½		¼-2		
" reducing									1-2				
" reducing, male & female									1¼-2				
" two-thirds									⅛-4				
Y, 45-deg.	½-5	3/8-6	½-12	1-12					½-4		3/8-2		
" reducing			1¼-12										
" double			1¼-10										
" 60-deg.			1¼-10										
" 60-deg, reducing			1¼-10										
" 60-deg, true, reducing			1¼-10										
" true, double			1¼-10										
" true, reducing			1¼-10										
" 90-deg.			1-12										
" 90-deg, reducing			1¼-8										

FITTINGS are used to connect the different units of a pipe line or to change its direction, capacity, or number of outlets. Generally speaking, these fittings are single parts such as couplings, elbows, tees, crosses, etc., or multiple-part fittings such as unions and Van Stone joints. There are two general classes of fittings; threaded or screwed, and flanged.

As a general rule, the screwed fittings are used on small-sized pipes and for pressures not exceeding 250 lb. per sq.in., while flanged fittings are used for high pressures and dangerous fluids in pipes of 4-in. diameter or larger. The exceptions to both these practices are so many, however, that it may almost be said that the use of screwed or flanged fittings is a matter of personal preferment. Screwed fittings are standard up to 12 in. and flanged fittings for pipe as small as 1 in. are carried in stock.

In choosing between screwed and flanged fittings, it must be borne in mind that the weak part of a pipe line is the threaded end of a pipe just where it enters a fitting, and that a pipe using a threaded flange is equally weak at that point.

The choice of type of fitting should depend upon the factor of safety justifiable against stoppage of operations, loss of material being conveyed, injury to workmen and facility of pipe replacement. In some cases, screwed flanges stiffen a pipe line and provide a sufficient factor of safety. In other cases a flanged pipe end with a self-adjusting collar, such as the Van Stone joint, is preferable, and in still other installations, the pipes are butt-welded to form a continuous line without fittings.

Fittings are made in approximately fifteen different materials, each of which has its specific use.

Screwed fittings are made in three styles, plain, and with a half-round or square bead. The plain fitting is used for gas or low-pressure fluids, and the beaded for medium pressures. Some fittings have wrench-hold ribs, but usually these are special. Where an exceptionally close make-up is desired, such as on a control board, or in close quarters, Christmas-tree fittings are used. Some of these fittings have all male ends, others all female ends or any combination of the two so that the fittings may be attached directly to valves, gages, and pipe, eliminating the use of nipples. They are used extensively in the oil industry.

The increasing use of welded pipe construction has brought about the development and manufacture of welding fittings. These fittings are sometimes made of pipe bent to different shapes and angles by either hot or cold processes, sometimes forged complete and at other times forged in sections and welded. Van Stone nipples, ready to weld to pipe ends, are available. Welded fittings are made in both wrought iron and steel.

Sweated and compression fittings are used principally on brass and copper tube. In using the first-named type the pipe is left straight and sweated into the fitting with solder and a small blow lamp or torch. With the compression fitting the end of the tube is belled or flared after the fitting is slipped over, and is compressed between two parts of the fitting. These fittings are used only on tube, not on iron-pipe-size brass or copper pipe.

Whether a nipple should be classed with pipe or fittings is not a question to be debated here. Suffice it to say that they are made in all standard pipe sizes from ⅛ to 12 in., and in standard, extra strong, and double extra strong thicknesses. The different lengths are: close, short, long, and extra long. The maximum length of a standard nipple for any size of pipe up to 8-in. diameter is 12 in. Nipples with right- and left-hand threads are standard in sizes from ⅜ to 2 in., the maximum length being 6 in. Special lengths are available, subject to extra charge. A ¾-in. pipe-size close nipple is 1½ in. long, a short nipple 1¾ in. Long nipples vary from 2 in. to 3½ in., and extra long nipples from 4 in. to 12 in. Galvanized nipples are special over 8 in. in diameter.

For ordinary purposes, fittings are made of cast, wrought, and malleable iron, steel, and brass. Each fitting is made in a variety of sizes and patterns.

The simplest fitting is the coupling, which joins pipe lengths together. There are five varieties of this fitting: standard, right- and left-hand, reducing, eccentric, and offset.

Elbows come also in five styles: 30-, 45,- and 90-deg., reducing, and street. There are, of course, many varieties of tees, return bends, unions, caps, plugs, bushings, and reducers, many of which are carried in stock while others are peculiar to some particular industry or installation.

The typical flanges are: raised, straight, tongue and groove, and male and female faces. They are made in both long- and short-hub lengths and are attached to the pipe end by caulking, rolling, welding, shrinking, riveting, or by threads. Then there are loose-flange types for drawing the upset ends of two pipes together. Many variations of this type are on the market, each having a special trade name, but the term Van Stone-type joint covers the entire lot.

Besides these standard fittings, there are many combinations. Unions with one part of ferrous material, the other of non-ferrous, male and female union-tees, drop elbows and tees, male and female extension fittings, street, and four-way tees, drop tees and cross-overs, also special lines of fittings for car, boiler, and locomotive work. These fittings are all small and of the threaded type.

What might be called a refinement is the double-sweep fitting in which the radius of the center line is about double that of the single-sweep, or standard, fitting. For highly viscous liquids, or where the flow rate is very rapid, double-sweep fittings are a decided advantage.

Industrially speaking, the purchaser will do well to order fittings in accordance with the Bureau of Standards Bulletin No. C.S. 6-29, effective Jan. 1, 1929, and with specification No. A72-27 of the American Society for Testing Materials.